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CONTENTS

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VOL. 37 NOVEMBER, 1939 No. 11

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EDITORIAL

THE COOPERATIVE FOREST RESTORATION BILL

IT IS almost universally agreed that progress in private forestry, with a few notable exceptions, has been discouragingly slow. Although it has become the mode to point an accusing finger at commercial forest areas, anyone familiar with the condition of the farm woodlands of the nation knows that they have received little, if any, better treatment than the commercial forest areas. For this condition the small owner of woodlands is no more or no less guilty than the large forest owner. Both indeed are subjected to the same inexorable economic pressures, and both indeed respond similarly to these pressures. Consequently, the result is the same—forest deterioration or forest destruction—even though the process in the two instances may be somewhat different.

For many years foresters and others have given considerable thought to the question of how privately owned forest land, whether it be in small woodland areas of 20 or more acres or large commercial forest areas of 20,000 acres or even 200,000 acres, can be restored. A considerable number of plans to accomplish this end have been considered from time to time, but only recently has one of these plans taken the form of a congressional bill. This act is the so-called Cooperative Forest Restoration Bill.

In a general way this bill provides for leasing depleted forest lands from farmers and others for a rental not exceeding the average of the taxes for the last five years. The taxes must be paid by the owner during the period of the lease.

The land would be managed according to proper forestry practices. The work would be done under a voluntary contractual agreement which would specify the kind and amount of work to be done and the estimated cost. The government would pay all expenses incurred on the land as provided for in the cooperative agreement or lease.

Preference in employment in the work undertaken would be given to owners and occupiers of the land and to qualified local persons in need of employment.

The agreement or lease would continue in force for a sufficient length of time to permit the federal government to recover 100 percent of the total expenditures it has made, including rental but not interest, except on areas of less than 500 acres, on which reimbursement to the extent of only 50 percent would be made.

The act further provides for the appointment by the Secretary of Agriculture of state advisory committees, consisting of the state forester, the state director of agricultural extension, a representative of the U. S. Forest Service, a representative of the Soil Conservation Service, and three legal residents of the state, one of whom shall be a farmer.

Supporters of the proposed legislation claim that if enacted and fully operative it would give part-time employment to over one million men; improve home markets for agriculture and industry; permit the private owner to keep forest land in permanent production without the usual carrying charges until the land becomes self-supporting; aid community finances by reducing relief rolls and tax delinquencies; and that it will result in an impressive saving of national relief expense.

No one familiar with the logged-off area in any of the once important forest regions will deny that the need for some action to alleviate the existing distressed conditions is urgent. The important question is not whether something should be done but what and how it should be done. Perhaps the Cooperative Forest Restora-

tion Bill is the answer—not a perfect one, to be sure, but a reasonable compromise of the many forces that impinge on the problem.

Because of the very large area—216 million acres—that conceivably would come under the provisions of the proposed bill and the large sums of money that would be expended, it would appear to be highly desirable carefully and critically to scrutinize the bill before supporting or condemning it.

It seems quite unlikely that the proposed bill would do all its supporters claim for it. If it would, the bill should be passed without a moment's delay. It should be remembered, however, in carrying out the provisions of the bill for a long period of years, hundreds of millions, if not several billions, of dollars conceivably might be expended in the name of forest restoration. Under such circumstances a certain amount of caution is in order.

Basically, the soundness of the scheme is predicated on the proposition that the federal government can pay existing taxes on cutover lands and farm woodlands, employ largely relief labor for forestry operations at going wage rates, and come out in the black. To be sure, no interest charges are involved in the operation, but even so there is room for honest differences in opinion concerning how successful the program would be financially even under such conditions. There is little if any experience in federal spending programs to warrant such optimism. The fact that the bill provides for a settlement on the basis of 50 percent of the cost on forest areas of 500 acres and less may be taken either as a tacit admission of the financial limitations of the program or a clear-cut willingness to subsidize forest restoration on farm woodlands and other small areas to the extent of less than one-half of the cost.

The emphasis placed by supporters of the bill on the employment the program would afford is disquieting. One is lead to wonder whether or not the bill is not somewhat opportunistic. Conservation and relief programs in some instances are already so inter-woven and confounded that their real objectives are no longer clear. Too many conservation programs are already riding the employment relief horse, and there is grave danger in the long run that sound conservation programs may suffer because of it.

One of the by-products of the Cooperative Forest Restoration Bill if enacted would be to place the federal government in rather direct control of a large aggregate forest area over which it now exercises little or no control. This may or may not be desirable, depending of course on the point of view. Some state agencies may object to the program merely because of this aspect of it, but such objections lose some of their validity unless the state agencies have a better program to offer.

Some may question the soundness of the federal government not charging interest on the tax advances for the land and the advances for forest restoration work. Although it would be quite proper for the federal government not to include interest in its cost computations if the land is to remain in federal ownership, a somewhat different situation exists when the land is to be restored to private ownership. The bill undoubtedly would receive more favorable consideration from orthodox economists if interest were included in computing the cost of forest restoration.

Still others may question why the federal government should pay a rental not exceeding the average of the taxes on the land for the last five years. In the cutover region of the Lake States and elsewhere, patently fictitious values have been placed on forest land by assessors and the taxes levied accordingly. If the rental of the land about equals the average tax for the past five years, it is quite likely that in eight or ten years the federal government will have an investment in the land greater than the average cost of much of the land acquired outright for national forest purposes. This provision in the bill, however, should have great "come on" value in so far as getting popular support for it, especially in the cutover and in distressed forest regions. Foresters should not, however, confuse such support with support based on seasoned judgment and sound experience.

Basically the real question is not whether the Cooperative Forest Restoration Bill will accomplish any or all of the stated objectives, but whether or not the American public and forest conservation will be served best by this particular program. It seems reasonable to suppose that in the long run the money expended on this program might be used as effectively, for example, to enlarge the national forest area. From almost every point of view the national forest program has been effective, beneficial, and desirable.

The bill undoubtedly has much merit. It should be critically studied by every member of the Society. To do less would be to ignore one of the most far-reaching forestry measures yet proposed in the United States.

GRADE CHANGE PROTECTION FOR VALUABLE TREES[1]

By A. ROBERT THOMPSON
National Park Service

Nearly everyone has noticed the death of trees around or adjacent to which grade changes have been made. Deaths from this cause are especially noticeable along the slopes of roads which have been recently constructed or realigned and in connection with operations around new buildings where grade changes are involved. Changes do not have to be great to cause serious consequences; fills of only a few inches of fine-textured soil may, and not infrequently do, cause death through a change of underground relationships. In the following article detailed methods are given for determining what trees should be protected and how to protect them.

THE number of trees affected by road construction has increased materially in recent years for reasons other than increased mileage. The modern tendency in road design is to increase the radius of both horizontal and vertical curves, increase shoulder widths and road surfaces, broaden roadside and interceptor ditches, and to "roll back" road slopes instead of dressing the roadside as relatively steep inclined planes. Although such work is necessary for engineering, safety, and aesthetic reasons, there is little question but that it widens the zone influenced by the road construction. Consequently, it increases the number of trees removed or affected and widens the road scar. For this reason, if for no other, the important trees adjacent to key roads and parkways are worthy of every justifiable effort to preserve them.

The Problem

Trees are respiratory organisms and as such absorb oxygen not only through the leaves, as is commonly known, but through the trunk and roots as well. Trees also require water for normal functioning so when anything happens to increase or decrease the normal amount of available water and air certain physiological changes are inevitable.

Another factor which affects tree health is the relationship of the tree to the delicately balanced flora and fauna of the soil, both macroscopic and microscopic. These soil organisms are not only vital factors in breaking down organic matter and making it available to the tree, but they also aid in keeping the soil mechanically suitable for root growth and in other ways are highly beneficial. The soil flora and fauna are themselves immediately dependent upon sound water and air relationships in the soil. Grade changes may interrupt their functions to a serious and perhaps fatal degree, so that the soil becomes, then, a medium unsuited for tree growth unless the latter is capable of adjusting itself to the altered conditions.

Some species, of course, are less susceptible to change than others, but no tree takes kindly to being deprived of its normal soil moisture or to having its trunk and roots buried in several feet of earth, thus cutting off necessary oxygen and perhaps drowning it with an overabundance of water. We have all seen occasional individual trees the root systems of which have been buried with a thick overlay of soil for many years without apparent injury, but usually a good reason for this may be found. Perhaps the tree is of a species which is unusually well adapted to change by its ability to form new roots readily; the fill has been very gradual or of a porous nature; or natural moisture and air relationships otherwise have been maintained in a sufficient degree to minimize the physiological effect of the changed environment.

It is sometimes possible to restore to health a tree which is suffering from the effects of grade changes, but often little attention is paid to such trees until symptoms become sufficiently pronounced to attract the attention of a layman. Undersized, chlorotic, or drooping leaves, an excessive number of dead twigs or branches, excessive adventitious growth, or sloughing bark are symptomatic of serious trouble when appearing on trees affected by changes in grade. Common sense would indicate that a proper solution would be to prevent the development of these and kindred symptoms by proved precautionary measures when the grading is done.

[1]Released also as Occasional Forestry Paper No. 2 by the Branch of Forestry, National Park Service, U. S. Department of the Interior.

What Trees Are Worth Protecting?

Adequate treatment preparatory to grade changes is expensive and not all trees are sufficiently important to warrant the expense involved. Considerable judgment needs to be exercised in choosing trees for treatment, especially along roads. Frequently the low relative value of a tree may indicate its removal to be more sensible than any type of protective treatment.

The term "important tree" is worthy of more complete analysis than is possible in this brief paper. It is suggested, however, that in determining whether a particular tree is worthy of a protection system the following factors, which are more or less interlocking, should be evaluated:

1. Size, condition, and species of the tree. Very young or very old debilitated specimens are seldom worthy of expensive protection. Frequently it will be advisable to sacrifice badly placed young trees and to depend on replanting or volunteer growth to cover the scar. Old trees should be carefully studied to determine if the life expectancy justifies treatment. Species which are normally long-lived are, of course, worthy of more consideration than short-lived species irrespective of present size or condition.

Other factors which should be considered before treatment is given are the probabilities of windthrow and sunscald. When a new road is cut through a stand, the resulting wind tunnels and increased exposure profoundly change environmental conditions along its course. Trees which have grown up in the protection of the stand now find themselves exposed to winds of different intensity and coming from different angles. It would be unjustifiable to give complete grade protection to trees which are more than likely to be endangered through the altered conditions of exposure.

2. Probability of serious insect or disease attack. While it is rarely possible to predict with assurance that a certain tree will become prey to fatal insects or disease, the presence or absence in the locality of insect or disease epidemics affecting the species should be carefully considered. For example, it would hardly be wise to provide an expensive protection system for an elm in the Dutch elm disease zone, a white pine in a blister rust area where no control is provided, or trees likely to be attacked by bark beetles when new roads are cut through forest areas.

3. Presence or absence of other trees which could take the place of a removed tree. A tree growing alone is, other conditions being equal, more worthy of protection than one located on the edge of a forest or as a unit of a grove. The amount, type, and rapidity of natural regeneration also play a part in a carefully considered protection program. Trees growing close to buildings or parking areas, in playgrounds, city parks, and private lawns, or along parkways and roads through pastoral scenery have, as a rule, a higher individual value than those in forest or thickly wooded areas and consequently are worthy of more consideration.

4. Location of the tree with regard to the safety of pedestrians, vehicular traffic, and buildings. Trees, which are dying, seriously ridden with insects or disease, structurally unsound, or obviously not windfirm, where falling trees or limbs would endanger persons, vehicles or buildings, should be removed preferably as they constitute an unwarranted hazard. Into this same category would fall trees which obscure vision at road intersections and curves or which are dangerously close to the paved surface.

5. Historical or special aesthetic considerations. Roadbuilders and designers not infrequently are confronted with the problem of preserving trees which by reason of historical association, extreme age or size, or special aesthetic value are worthy of preservation. When planned construction work would involve trees in this class, a change of plan or realignment may be warranted to avoid any threat to the continued existence of such specimens. If changes of plan cannot be made, such trees are worthy of the highest degree of grade protection.

6. Degree of grade changes involved. The amount of cut or fill which affects the tree under consideration will have a major bearing upon the extent of grade protection necessary to preserve it—indeed, it is one of the principal governing factors in determining whether protection is desirable at all. While it is possible and frequently desirable to provide protection for trees affected by moderate cuts and fills, if the change in grade is excessive, the expense of protection might conceivably be greater than the value of the tree in question. Sound judgment and a keen appreciation of the values at stake are needed.

Protection Principles

Reduced to essentials, the objective in counteracting the ill effects of grade changes is to pre-

vent as nearly as possible the upsetting of the normal balance of air, water, and other subsurface relationships. No hard and fast rules can be laid down for solving this problem because no two trees live under exactly the same environmental conditions.

The usual corrective for a raise in grade around a tree has been to build a masonry well around the trunk. Many of these wells unquestionably have been a factor in preserving the health and vitality of buried trees, but too often the well has merely prolonged the tree's life for a short period. Proper protection is not so simple.

Techniques preparatory to grade changes will vary with such factors as the location, species, size, age, value, and condition of the tree or trees involved; the depth of the cut or fill and the degree of slope; the physical and chemical characteristics of the original soil and that to be used for the fill; the amount of soil moisture present; and changes in surface and subsurface drainage to be anticipated.

Raising Grades—Ideal Aeration System

The type of treatment described below is applicable to trees of the highest individual value such as important trees in public use areas, lawns around homes or public buildings, and playgrounds.

The first step in a practical aeration system is the preparation of the normal ground surface including the removal of all living vegetative cover, sod, and green organic debris. It is well to cultivate all the soil surface beneath the tree's crown, but the roots should be disturbed as little as possible unless the area has suffered considerable compaction, when it will be desirable to aerate the soil as deeply as necessary to break up the compaction layer.

Most authorities and experienced arborists believe that it is desirable at this point to fertilize trees to assist them in overcoming the inevitable changes which lie ahead although agreement is not complete. Considerably more scientific investigation is required on the subject. If fertilization is deemed advisable under local conditions, a normal dosage—say three pounds per inch of trunk diameter, breast high, of a 10-8-6 or a 10-6-4 fertilizer—may be applied to a deciduous tree by any one of the standard methods so long as it is well distributed. Less is known of the effects of fertilizers on conifers, but it is believed that not over one-half of this dosage should be applied to the average conifer under similar conditions; indeed, chemical fertilizers should be used with considerable caution on conifers under any circumstances, particularly under wild or semiwild growing conditions.

A circular system of 4-inch porous agricultural drain tile is then laid on the ground under the drip line of the crown. In excessively wet soil or in low spots the tile preferably is laid in a very shallow ditch and is surrounded by gravel or crushed stone. Four to eight additional tile lines should be laid radiating out from the trunk and extending to the circular system so that in plan the entire system resembles the rim and spokes of a wheel. (Fig. 1, *A*.) For trees of great size or under conditions of excessive moisture, it may be necessary to supplement this tile system with additional circular tile lines between the tree and the drip line and in some cases outside of the drip line. The gradient of the tile lines is determined preferably by instrument to assure that there will be no dips or humps in the system and to plan for drainage away from the tree in one or more directions. Tile lines which would drain toward the tree should be omitted. All tile joints should be covered with a piece of tarred paper to keep out debris.

At a reasonable distance from the trunk a dry well is laid up with the coping flush with the final ground surface. (Fig. 1, *B*.) The inside diameter of the well should be governed by the growth probabilities of the tree. A small tree needs, relatively, a greater diameter well than one which nearly has reached its anticipated girth. The well should be so constructed that the radiating tile lines start at the very bottom of the inner wall of the well and radiate outward undisturbed. As many voids as possible should be left in the walls of the well to permit an exchange of air and moisture through the porous fill which is to be placed outside the well. Large stones, approximately even in size, are generally used for this purpose, but brick, discarded building tile, or concrete blocks are quite satisfactory if laid up with the openings extending clear through the wall of the well. It should be noted, however, that any remnants of lime should be avoided, especially with conifers.

It is a good plan to add enough rocks and gravel to the bottom of the well just to cover the drain tile openings. This will facilitate drainage

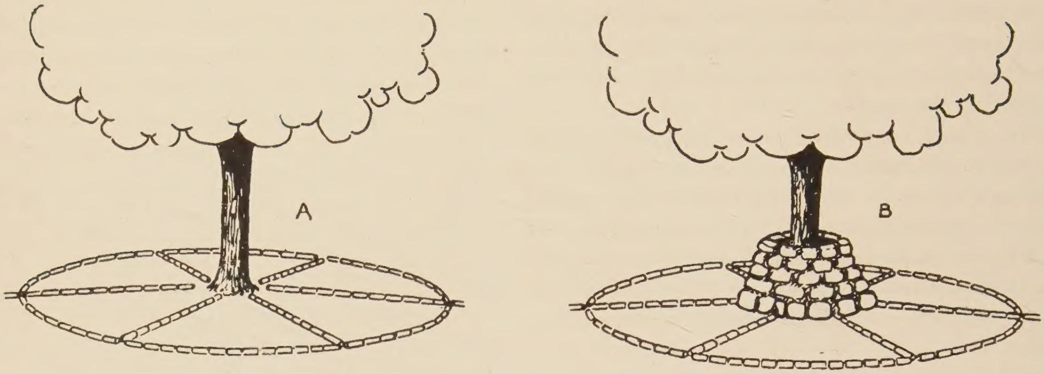

Fig. 1.—*A*, horizontal field tile. *B*, construction of dry well.

Fig. 2.—*A*, vertical tiles erected. *B*, placing of rock fill.

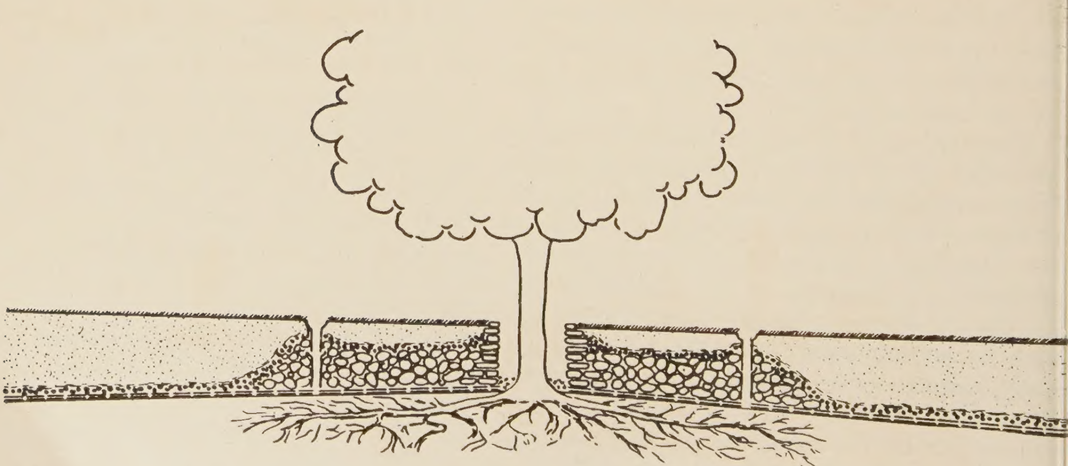

Fig. 3.—Cross-section through tree showing ideal aeration system.

and aeration and prevent the tile lines from becoming clogged with debris.

When the tree in question is so located that the open well presents a safety hazard, such as might exist in a playground or similar public use area, an iron grate may be provided if the expense is warranted; a barrier fence may be built around the top of the well; or the inner wall of the well may be curved inward toward the top thus avoiding a wide space between the trunk and the well at the ground surface. Another method of avoiding the hazards of an open well is to fill it with rocks. These may be removed periodically to avoid any growth constriction and replaced in slightly different positions.

In order to permit a circulation of air through the fill at the extremities of the branch spread, provision must be made to connect the radiating and circular tile lines to the new ground surface. This is perhaps best provided by erecting vertical sections of bell tile at the intersections of the tile lines. (Fig. 2, *A*.) The horizontal lines are brought together so that a 6-inch bell tile can be placed over the joint. It may be held erect during construction, bell upwards, by blocking with stones. As many sections of vertical tile should be used as are necessary just to reach the finished grade of the fill. Temporary wooden or rock plugs, placed in the mouths of vertical bell tile, will prevent the sifting in of dirt and debris while the fill is being made.

Large stones, rather evenly sized, are then laid over the entire area encompassed by the tile field and may well be extended several feet beyond. (Fig. 2, *B*.) The depth of the stone layer is governed by the total depth of the fill. For example, a shallow fill of perhaps a total of two feet will permit only about one foot of stone fill, whereas in a deep fill a greater depth of stone may be beneficial. It is doubtful, however, whether stone fills greater than thirty inches are needed for maximum efficiency. The stone should be laid rather than dumped to permit the leaving of as many voids as possible and to prevent injury to the tile.

A thinner layer of crushed rock or smaller

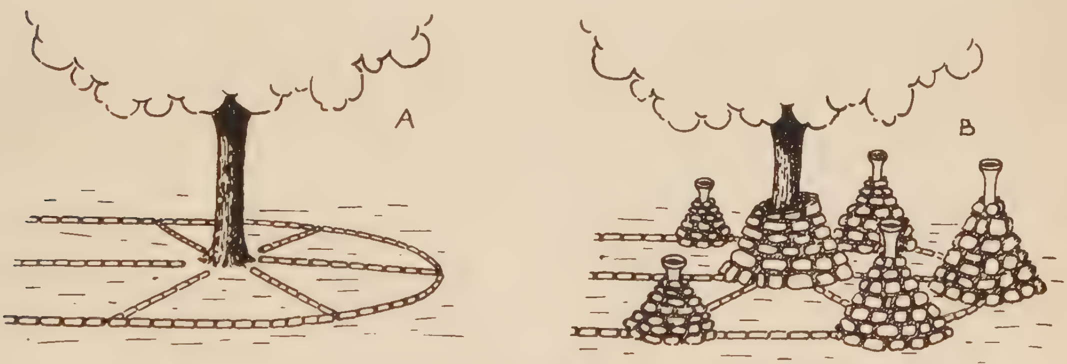

Fig. 4.– *A*, tile field for tree in road slope. *B*, well and vertical tiles erected.

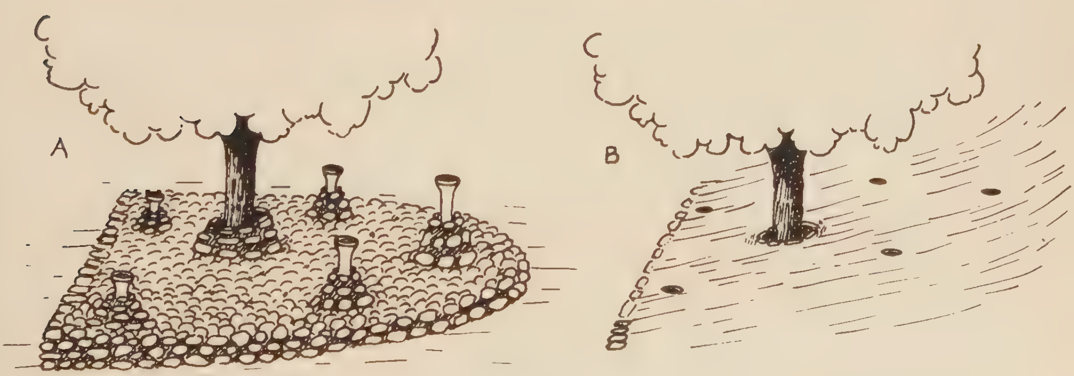

Fig. 5.—*A*, rock fill; dry wall at left. *B*, completed grading.

stones may be placed over the large stones to fill the surface voids. This is followed by a thin layer of hay or straw just thick enough to prevent the future fill of soil sifting down and closing the lower voids. For conifers a layer of fallen needles could be used. Sufficient topsoil of good tilth is placed on the hay to bring the fill to the desired grade. (Fig. 3.)

In order to keep the vertical tiles from filling up with debris the best method is to fill them to the ground surface with large rocks or large-size crushed stone, leaving all possible voids to facilitate aeration, watering, and fertilization.

Raising Grades—Road Slopes

Trees growing in locations which eventually will be road slopes may be treated somewhat differently as to details, but the principles involved are the same as for normal raises in grade around trees, provided the value of the trees warrants such treatment. Instead of a circular and radiating tile system, the perimeter tiles may be laid in a U-shape under the drip line of the crown with the ends of the "U" extending downhill and outward to the face of the proposed slope. Supplementary tile lines may be laid as shown in Figure 4, *A*.

The tree well is constructed essentially as described previously with the coping flush with and on the same grade as the finished slope. Vertical tiles are erected as described previously (Fig. 4, *B*).

If any of the vertical tiles would extend into the area which will be surfaced for traffic, such vertical tiles preferably are omitted from the protection system. Some means of keeping surface road drainage away from the treated area by curbs or shallow ditches should be incorporated in the protection scheme.

The preliminary stone fill is laid the same as for a normal fill, but it is beneficial, if the appearance is not objectionable, to have some of the rock fill exposed on the slope for purposes of aeration where the final surface is graded. (Fig. 5, *A* and *B*.)

A modification of this type of protection is shown in Figure 6, in which a U-shaped open well is used instead of one of circular shape. When adaptable to local conditions, this type of well is more desirable than those described previously since more of the original soil level is left undisturbed.

When valuable trees are located in or at the toe of slopes adjacent to roads or other large construction operations, any good accomplished by an aeration system may be nullified if the trunk is not protected from blasting, rolling stones, and other injuries during the construction. A tree badly scarred is an open invitation to insects and disease; hence all possible care should be exercised to prevent injuries by the erection of log or heavy board barriers on the side or sides of the trunk liable to damage. Unpreventable scars should, of course, be traced to a streamlined perimeter to promote healing and painted with a suitable tree dressing to retard or prevent decay, but most tree scars are preventable if a little judgment is used.

Raising Grades—Modifications for Economy

When the economy of the operation or the questionable value of the tree will not permit the expense involved in the construction of an aeration system of one of the types previously described, several modifications may be adopted although it should be realized that the chances for survival of the tree are lessened thereby.

Modifications may include the elimination of the horizontal tile field, if adequate drainage otherwise is assured; vertical tiles, if blind wells can be substituted; the tree well, if the rock fill is brought up to the surface around the tree.

Sketches illustrative of these modified systems are shown as Figure 7, *A*, *B*, and *C*.

Lowering Grades

The problems presented when grades around trees are lowered are quite the opposite of those described previously. The root areas of trees which have been left standing close to an edge of a cut bank or road slopes usually are aerated sufficiently, if not excessively, but the moisture supply is reduced because of soil drying and removal of protecting surface soil and vegetation. Root cutting also is often a serious problem.

Some changes in fundamental soil relationships usually are inevitable, but the effect of the

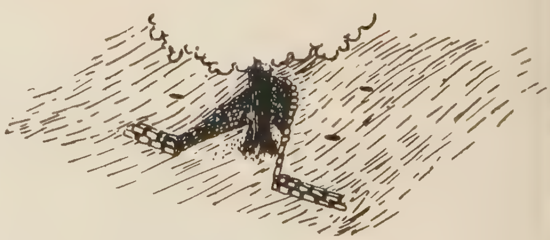

Fig. 6.—Modified dry well for tree in road slope.

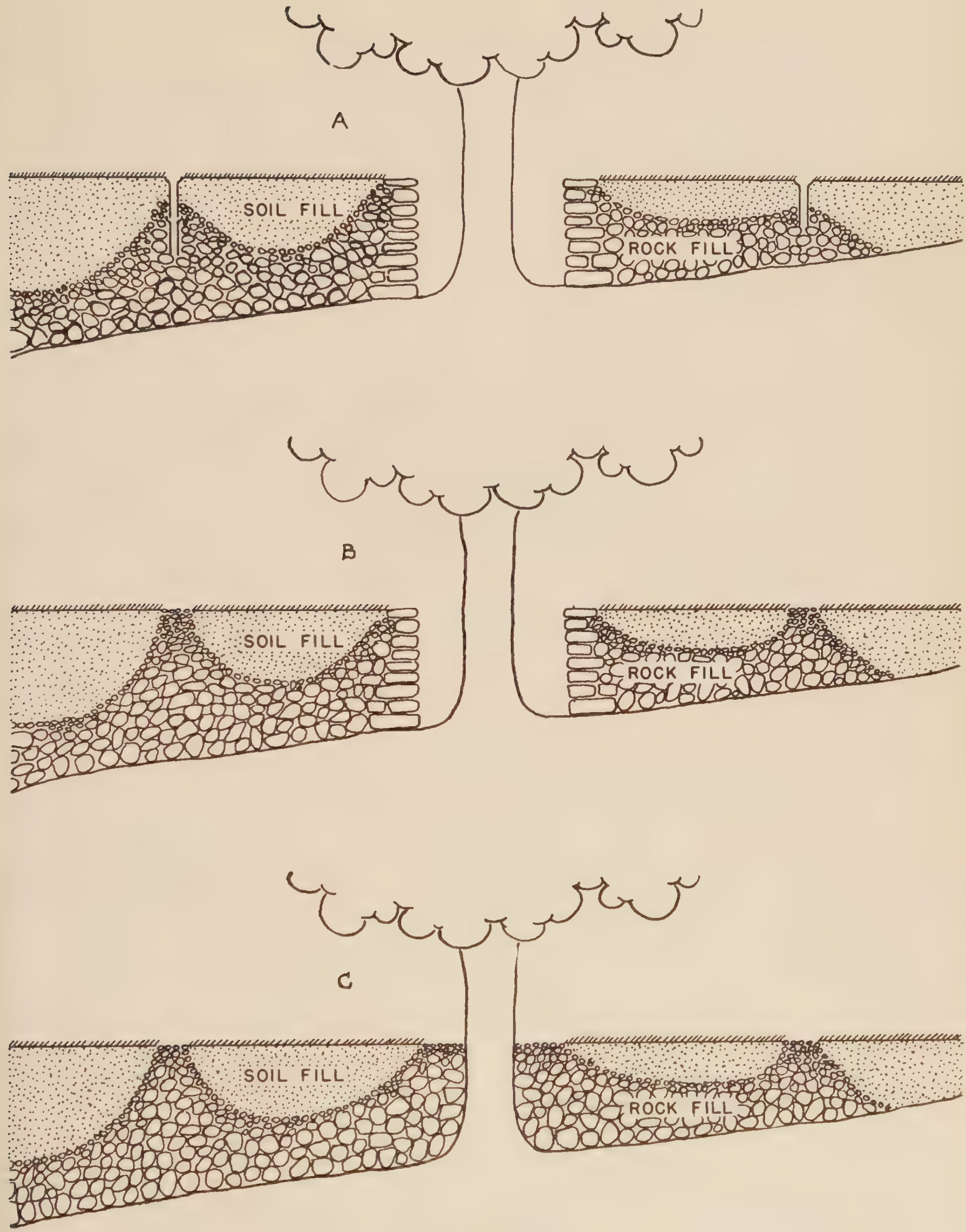

Fig. 7.—Modified aeration system. *A*, showing horizontal tile omitted. *B*, showing horizontal and vertical tile omitted. *C*, showing all tile and tree well omitted.

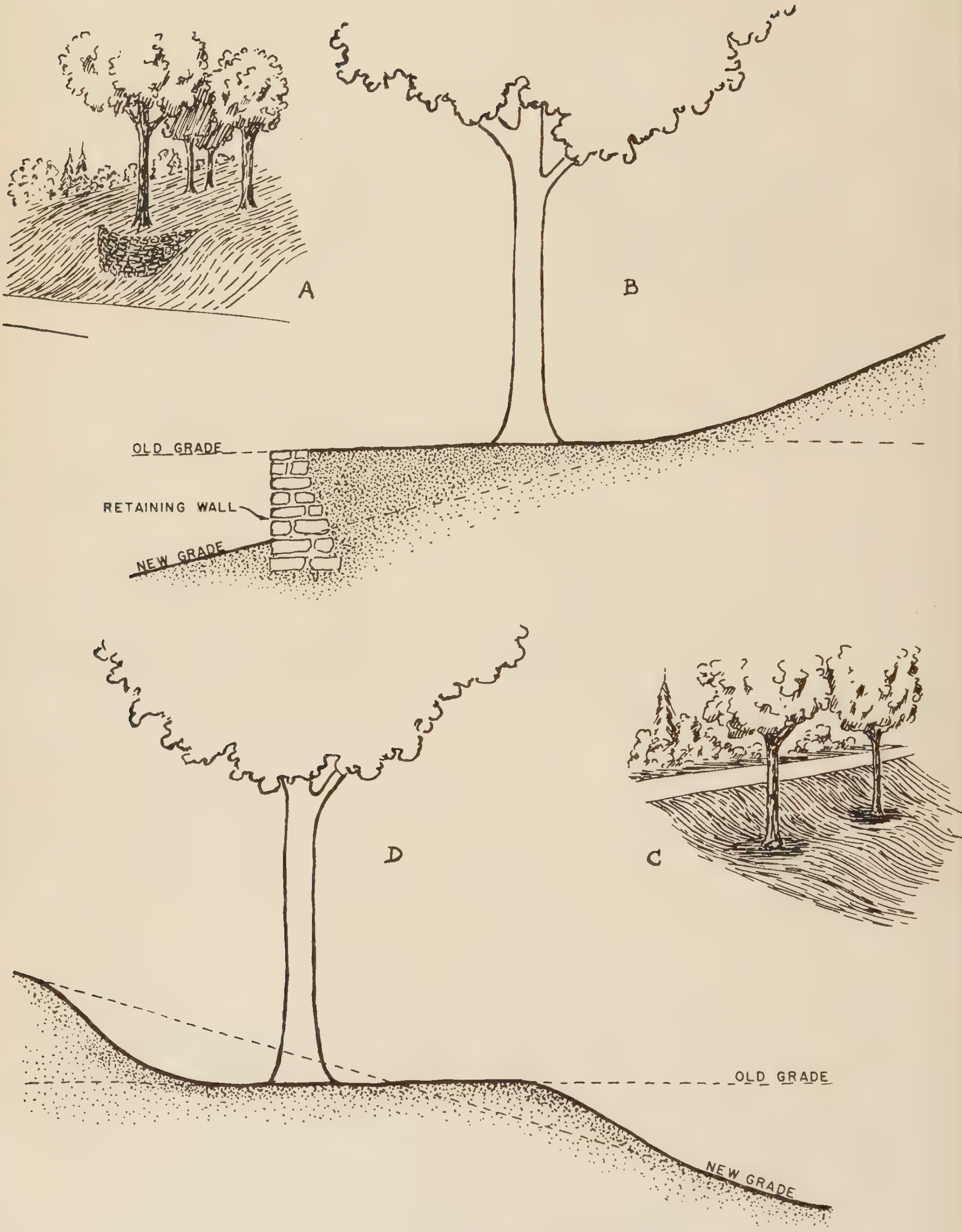

Fig. 8.—*A*, masonry retaining wall erected. *B*, cross section of modified aeration system showing use of retaining wall. *C*, molding of slopes. *D*, cross section of modified aeration system showing molding of slopes.

changes often may be minimized or ameliorated by measures designed to prevent excessive drying of the soil, to increase the moisture-holding capacity of the soil, and to stimulate root development, particularly the deeper roots and those in the least affected part of the root system.

Excessive drying of the soil may result from three main causes: reduction of soil moisture, surface evaporation, and removal of sheltering vegetation. In most soils capable of sustaining plant life, the soil water level tends roughly to parallel the surface of the ground. It is important, therefore, that as much as possible of the normal soil level around trees be retained when the general gradient is lowered. This is a matter of close supervision at the time of the road building operation. The preservation of trees of outstanding merit, where the cost is justified, occasionally may warrant the erection of masonry retaining walls, (Fig. 8, *A* and *B*), where necessary to preserve as much as possible of the normal relationship of the root system to the original ground surface.

A preferable modification of this plan, sometimes observed, is to mold the ground surface around the tree into the new general slope instead of arbitrarily cutting slope and roots to conform to a uniform gradient. (Fig. 8, *C* and *D*.) In either case an extreme effort should be made to avoid cutting off an appreciable part of the root system.

The moisture-retaining capacity of the soil may be increased by providing a mixture of peat moss or leaf mold and soil for the back fill placed behind the previously mentioned walls. Mulches of leaf mold, straw and hay are extremely beneficial and, of course, the establishment of a permanent plant cover is highly desirable.

In order that the part of the root system least affected by grade changes may be better able to take over at least a part of the functions of the injured portion, practices designed to stimulate root growth frequently are beneficial. Deep fertilization, mulches, cultivation, and watering, when possible and practicable under existing conditions, will be beneficial for this purpose.

It should go without saying that all reasonable care should be exercised in operations involving changes of grade to prevent soil erosion by the planting of trees and shrubs, surfacing with protective mulches, sodding, and similar measures designed to hold the soil and cover the construction scars.

Forest Fires in United States in 1938

An average of one forest fire every two and a quarter minutes occurred in the United States during 1938. They burned over 33,815,100 acres—an area almost as great as the State of Arkansas—and caused damage estimated at $36,888,460, according to the annual summary of forest fire statistics compiled by the U. S. Forest Service.

Of the 232,229 forest fires in 1938, 9,873 occurred upon government-owned or administered lands under the protection of the Forest Service, while 76,326 were upon state and private property protected by the owner either in cooperation with the United States or otherwise, and 146,030—or 63 percent of the total—were upon state or private holdings not protected.

There are 659,202,090 acres of land in the United States on which forest fire protection is essential. Of this total, 191,860,240 acres are classed as federal lands and are under the protection of the Forest Service and other federal agencies. Of the remainder, owned by state or private interests, 308,458,000 acres, or about 66 percent, are under some degree of organized protection, largely under Clarke-McNary cooperative agreements which provide for allocations of federal funds to the states on a matching basis for forest protection purposes. This leaves a total of 158,883,850 acres of private lands needing protection but not protected.

WHY NOT GIVE EXISTING PROGRAMS A FAIR TRIAL?

By M. H. BRUNER
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The necessity for improved forest practice on private lands is admitted, but the plea is made that owners are making progress and should be given ample opportunity to show what they will do voluntarily with increased technical advice from state and federal agencies before any form of public regulation is put into effect.

THE January 1939, issue of the JOURNAL carried an article by Conrad H. Hammar entitled "Extending Public Control and Management of Forest Land Without Purchase." In brief, Hammar states that "present day techniques of extending control and management to lands needing reforestation in the United States are still inadequate," and therefore suggests a method whereby private ownership could lease land to the federal or the state government, which "would undertake the management, development, and control of the land," pay the local taxes, and return a portion of the income to the landowner whenever forest products are sold, depending upon the amount expended in producing the forest crop.

A casual reading of Hammar's statement might leave one believing in the broad principles suggested; however, when a careful analysis is made of the basic ideas involved, some doubts begin to develop.

These basic ideas are: (1) that present programs have failed to bring about desirable timber management practices on forest lands; and (2) that adoption of an adequate plan is necessary so that "management and control" can be extended "to the 70 percent of forest land still owned by individuals."

Before attempting to consider several of the minor subtopics advanced in Hammar's paper, I offer an analysis of these two principles.

1. How far should we attempt to go in public control of private forest land?

Hammar suggests that it seems expedient to extend public control to all present and potential forest land, regardless of ownership. He justifies this opinion upon the attitude expressed in the 1938 annual report of the U. S. Forest Service, and on his own knowledge of forestry conditions in Missouri.

It is unfortunate indeed that the U. S. Forest Service should maintain an attitude which certainly is greatly at variance with that of the majority of foresters, especially in the South. Recently reported timber surveys are showing that the danger of a "timber famine" is much more remote than had been suggested in the Copeland Report and other similar statements prepared by the Forest Service during the last decade. The Copeland Report, for example, shows a total sawtimber volume of 200 billion board feet for the 11 southern states which include 190,000,000 acres of forest land; whereas preliminary figures from the Forest Service timber surveys, reporting on 46 million acres included in eight survey units, show 74 billion board feet. In other words, this sample indicates that the forest survey is finding considerably more timber in the South than was estimated in the Copeland Report.

Then, also, the South in general is rapidly becoming "timber-minded." This can be attributed largely to recent developments in diversified forest industries in the South in which pulpwood leads the list. It logically follows that these new industries present increased opportunities for private forestry, which naturally must be guided by the profit motive. The majority of foresters in the South, who are in close touch with the progress that private forestry is making, generally agree that private forestry will succeed simply through application of good business principles in the management of their own lands, provided that adequate legislation is afforded in taxes and fire protection.

It would be politically unwise and economically unsound to attempt to expand public control to all forest lands, such as Hammar suggests, in referring to the situation in Missouri. Doubtless the situation is more acute in Missouri than generally in the South because physical conditions are not as favorable to private forestry. According to the Arkansas Forestry Commission, Arkansas—a neighboring state—is finding private forestry a very profitable enterprise. There are now 1,700,000 acres of commercial forest land in

Arkansas under a constructive program of management. This does not include the numerous farm forests that are being brought rapidly into the management program through the educational work of the Extension Service in demonstrating the value of the forest to the farm economy.

The situation in Arkansas is fairly typical of the South. In other words, private ownership will adopt forestry practices as rapidly as sound economic principles permit; and as soon as foresters are able to point out the essentials of practical "dirt forestry."

Hammar's program, therefore, might be acceptable to Missouri, but certainly not to the most important potential forest area in the United States—the South. This limitation should have been stated clearly in his paper; instead, however, he considers that the situation in Missouri is generally applicable to the whole nation, and recommends his program accordingly.

2. Have present programs failed?

Foresters in the South are generally very enthusiastic with the progress private forestry has made during the past decade. Until 1933, only two public agencies were organized specifically to assist private forestry! These were the state extension services and the forestry commissions. But both of these agencies have been impeded because of inadequate funds. The C.C.C. program, originating in 1933, did much to arouse an interest in state forestry work. In Arkansas, for example, it materially assisted the state forester in building a program, the foundation of which was laid in 1932. Could one argue that a program has failed which can report the progress Arkansas has made during the brief period of six years?

Extension services can report similar trends in their educational work through county agents. Yet this program developed largely following the Clarke-McNary Act of 1924. However, the Extension Service program always has been hindered by inadequate funds, because full appropriation authorized under the act has never been voted. Even today, Florida has no extension forester.[1] North Carolina has been able to develop the most aggressive farm forestry program in the South, having had two extension foresters employed for the greatest length of time.

[1]Editor's note.—Florida has an "extension forester," but he is not technically trained.

The Soil Conservation Service, developing from the New Deal program of 1933, is projecting a splendid farm forestry program, in cooperation with the state extension and forestry services. Through the recently created soil conservation districts, it will be able to expand a program which will have a far-reaching effect upon farm forest management. During 1938, for example, over 12,270,000 trees were planted on farms in soil conservation districts in South Carolina alone. Is this program failing?

Not until 1937, did the U. S. Forest Service finally organize a regional program to include assistance for state and private forestry work. The wisdom of this program is now being felt through the valuable assistance given the state agencies. One certainly cannot say that this program has failed since it obviously has not had time to show results!

The logical approach to the question of private forestry, therefore, seems to be in giving existing programs a fair trial, extending public control only after private forestry has definitely shown its inability to develop a constructive program in the face of changing economic situations. It seems reasonable also to suggest that if private forestry fails, foresters should be held responsible for not developing the essential leadership. In view of increased private forestry interest, which has been outstanding since 1933, it seems that the practical information resulting from research programs of the Forest Products Laboratory, the regional forest experiment stations, and of others, will point the way for a continued upward trend in private forestry interest.

Objections to Details of Hammar's Plan

In order to make a more detailed analysis of Hammar's program, it seems necessary to mention a few of the details presented, some of which are considered briefly in the following discussion.

1. Would the program provide for the real needs?

It seems that this point can be raised logically since usually the forest lands requiring greatest attention are associated with soils, topography, and climatic conditions somewhat adverse to private forestry. To bring the problem closer to conditions in Missouri, upon which Hammar bases many of his points, consideration is given to a recent study of the tax delinquent situation

of forest lands in Arkansas by Craig and Hall.[2]

This study pointed out the need "to effect a permanent improvement in the tax delinquency situation in Arkansas through providing for further demonstration and extension work in forestry and in assisting all timberland owners in managing their timberlands." They continue, "neither the federal nor state governments can absorb in perpetuity" the large tax forfeiting area, and suggested that "methods must be found to prevent its forfeiture . . . owners must be educated to practice forestry, at least to the extent of fire protection, protection against overgrazing, stand improvement. . . ."

Educational methods, therefore, were the basic recommendations suggested by Craig and Hall toward solving the serious tax delinquent situation in Arkansas. This procedure was recommended in the face of their study, which showed 2,843,453 acres of land delinquent as of January 1, 1934. How natural it would have been for them to suggest a more hasty approach in solving the problem by paying less attention to sound economics, and through methods involving autocratic procedures arising from the federal and state governments!

In developing broad policies dealing with the management of private forest lands, we must not overlook educational processes in paving the way for a sound program that is consistent with the thinking of those upon whom the policies have a personal bearing.

Hammar furthermore suggests that "perhaps the greatest advantage of the (his) plan occurs in connection with lands of relatively high value or those most unlikely to be reached by any program of ownership acquisition." This is indeed a very weak point to suggest as one of the key advantages of the program, because lands of relatively high value are usually in such condition that the landowner can be shown profitable timber management practices. Certainly most foresters agree that private forestry should be encouraged on land in this condition.

Except for a program of education and fire protection, which should be increased through expanded appropriation under the Norris-Doxey and Clarke-McNary Acts, what other program can be suggested that is economically sound in answering the present forest land needs of the Ozark region? Hammar speaks very loosely about reforestation but the Ozark National Forest has been having serious difficulty in this work. In some instances it has had to spend over $20 an acre to establish a satisfactory stand. The failures resulted largely from site, climate, and grazing. One might wonder, therefore, if control of similar lands in the region were taken over by the public, what returns the owner could expect if planting or other improvement costs were charged against the land. The only sound solution to the Ozark situation for the time being seems to be education and adequate forest protection. Provided with adequate funds, the existing agencies in the state could go a long way in accomplishing these programs.

Furthermore, many farms situated in the Arkansas Ozarks are greatly burdened by mortgage. Farm woodlands associated with mortgage indebtedness are usually seriously over-cut, and need assistance. But one can question whether the public, through Hammar's plan, could afford to write a contract to include ownership in this condition. This would certainly be a bad risk.

2. What about the soil conservation districts?

The next question that arises involves the soil conservation district laws which have been passed by most states to facilitate cooperation between agencies within the states and the Soil Conservation Service in erosion control. In many states, these districts are being created and perhaps will eventually be enlarged to cover most of the state, especially when soil erosion is a serious problem. This program is organized in such a manner that it would be possible to include in its program some of the ideas discussed by Hammar, without setting up forest conservation districts such as he suggests. Routing such a program through the soil conservation districts seems logical since they are in position to give assistance to all classes of land, and could therefore work out a satisfactory solution for farmlands as well as for forest lands. This applies especially to forested areas such as are found in the Arkansas Ozarks, where farmlands and farm forests are scattered throughout the larger bodies of commercial forest lands. This program would build up the economic condition of the farmer who has ownership of 57,000,000 acres of woodlands in the South alone.

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[2]Craig, R. B., and O. J. Hall. Tax delinquency of forest land in Arkansas, 1932-1933. Univ. Ark. Coll. Agric. Exp. Sta. Bull. 340. 1937.

BLISTER RUST CONTROL IN THE INLAND EMPIRE

By HERMAN E. SWANSON

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By the time white pine blister rust was discovered in the West, the life history of the fungus causing the disease was already well understood and control methods satisfactory for eastern conditions already had been developed. Because of the size of the task and also because of the inaccessibility of many of the western pine and sugar pine stands, the control of white pine blister rust in the West appeared to many an almost impossible task. Nevertheless, the Office of White Pine Blister Rust undertook the control of white pine blister rust in the West. The progress made to date is amazing, and with adequate support the task can be completed. The control of white pine blister rust in the West must be regarded as one of the greatest forestry achievements in the United States.

WHITE pine blister rust is the most injurious and threatening of the epidemic forest-tree diseases in the West. It was accidentally introduced into British Columbia about 1910 and was discovered in Vancouver in 1921. By natural means this destructive disease has spread to five western states, Washington, Idaho, Oregon, Montana, and California. In 1937 scattered infections on wild currants and gooseberries were found in Montana within 19 miles of Yellowstone National Park and in California 125 miles south of the Oregon-California state line. The first infected white pines were found in the Inland Empire in 1927, although it appears that the disease reached this region in 1923. Since that time the disease has developed at an alarming rate on the unprotected areas. Extensive surveys were carried on in the Inland Empire during 1936 and 1937. In 1936 about 4 percent of the young white pines in the Clearwater and St. Joe sections of northern Idaho were visibly infected with blister rust, and in other sections of the Inland Empire the amount of pine infection ranged from a fraction of 1 percent to 1 percent. During 1937 the survey showed 13 percent visible infection on the young white pines on the St. Joe National Forest.

After the discovery of white pine blister rust in the West, steps were taken to locate the disease and follow its spread from year to year, and a survey was made to locate and map the valuable commercial white-pine areas that should be protected. The completion of this survey showed 2,710,129 acres of white pine that were of sufficient value to justify the cost of protection. Minor adjustments in the boundaries of these areas have been made from year to year, but the total acreage involved has remained approximately the same as a result of both additions and reductions in the control areas originally set up.

Experimental work was also started to develop practical methods for eradicating and destroying ribes. At the present time four primary methods have been developed for the successful elimination of ribes from the white pine forests. Hand pulling or grubbing is employed to the greatest extent, 1,700,851 acres having been covered, 320,111,677 bushes destroyed, and 1,266,607 man-days used with this method. This comprises 94 percent of the acreage covered, 98 percent of the ribes eradicated, and 94 percent of the man-days employed. For this method the most efficient size and formation of crews had to be developed. Practicable methods had to be worked out for marking the strips of ground as they were worked to prevent duplication of work. Several tools have been developed for the use of workers eradicating bushes by hand. On areas where the ribes could not be readily pulled up by the roots because of their size or because of their position in rock crevices or under windfalls, an auxiliary method has been developed whereby the ribes are cut off through or below the crown and the portions of exposed crown or roots left in the ground are treated with about 2 ounces of a dry mixture of borax and sodium chlorate.

There are areas, however, and certain species of ribes that present difficult problems which cannot be treated by the hand pulling or grubbing method. These problems are found in connection with *Ribes petiolare* and *R. inerme*, found in alluvial bottom land where they grow in great numbers with a great proliferation of underground stems. A chemical eradication method has been developed which successfully destroys *R. petiolare*. The chemical used is sodium chlorate, and it is applied in solution by the use of specially designed power and portable knapsack

sprayers. This method ranks second in point of acreage covered. A total of 21,520 acres has been worked, 4,746,362 ribes bushes destroyed, and 58,239 man-days used by this method.

Other methods had to be developed for destroying ribes on areas where hand pulling was ineffective and where chemical treatment was too costly. The most troublesome of these areas are represented in the alluvial bottom lands supporting dense concentrations of *R. inerme* growing in tangled masses with other brush species. To meet this problem of ribes eradication two mechanical methods have been used. They are the bulldozer, or machine, method and hand slashing. Both methods involve the clearing of the ground by the complete removal of brush and ribes. This material is piled in long windrows or individual piles and burned. The bulldozer method, which is the more satisfactory from the standpoint of costs and the condition in which the area is left, employs a tractor of the caterpillar type equipped with a frame holding a series of digging teeth mounted in the front of the machine. In clearing the area of brush, the machine is operated much the same as the bulldozer used in constructing mountain roads. Areas cleared in this manner are seeded to grass, and many of them have been put under cultivation or used for pasture. This prevents the reestablishment of ribes on the area. A total of 1,877 acres has been treated by this method.

The slashing method accomplishes somewhat the same results as the bulldozer method and is applied to small, inaccessible, or especially swampy areas where it is not feasible to import and use a bulldozer. Approximately 1,578 acres have been treated by the slashing method.

Two questions are invariably asked by both the layman and the scientist. The first is, are the efforts to date successful in stopping the disease? The second is, how many times must an area be worked before control is accomplished? Reports on the progress of ribes eradication do not furnish answers to these questions, which are concerned primarily with the status of control on areas on which ribes eradication work has been done. In carrying out the ribes eradication program in the Inland Empire through the year 1937, 1,704,701 acres were worked at least once, 105,961 acres were given a second working, and 4,901 acres a third working.

What does this mean in respect to stopping blister rust? By virtue of the manner in which the disease spreads from ribes to pine, the suc-cess in accomplishing its control is measured in the effectiveness of the program in eliminating the ribes from these areas. Of the 1,704,701 acres on which at least one working has been performed practically permanent control has been accomplished on 713,715 acres, or 42 percent of the entire worked area, by the complete elimi-nation of ribes or by their reduction to 5 feet or less of live stem per acre. On this area no fur-ther work is necessary until some activity, such as logging or fire, disturbs the ecological condi-tions on the ground and causes the germination of any ribes seed that may be present in the duff. There are 357,084 acres, representing 2[illegible] percent of the worked area, on which it is too early to determine whether control has been es-tablished, that is, whether the ribes has been permanently suppressed for the life period of the present stand of timber. Further inspections on this ground are necessary to determine its status but on such portions as have been inspected it has been found that approximately 50 percent is in a satisfactory condition while the rest requires rework. On the remaining 633,902 acres, repre-senting 37 percent of the worked area, it is defi-nitely known that rework will be necessary.

Whereas complete and permanent control ma[y] not have been accomplished in the last two class-es of areas, the great reduction in the ribes pop-ulation as a result of the work has greatly re-tarded the intensification of the disease when it was already present.

Although the time since the major part of the ribes eradication work was done has been too short to gain an adequate measure of the amount of subsequent infection, several studies have been made to gain information. A study made in 193[illegible] on nine infected areas in northern Idaho showed the following results: On five of these areas, con-taining 7,701 pines, where ribes eradication was initiated in 1929 and 1931, it was found that 13.2 percent of the pines were infected, 12.[illegible] percent before ribes eradication and only 0.[illegible] percent afterwards. On the other four check areas, containing 1,135 pines, on which ribes eradication work was not done, 30.8 percent of the trees were infected, only 2.8 percent being infected before 1930 and an additional 28 per-cent during the years 1930-1932. This increase shows the effectiveness of ribes eradication in preventing pine infection. The comparison is more striking inasmuch as on the areas where

control work was done 12.6 percent of the pines were infected prior to control work, whereas on the check areas the initial infection was only 2.8 percent. A strip survey conducted during the summer of 1938 over an extensive area in the Clearwater National Forest indicates the effectiveness of the control work in stopping further intensification of the disease. Out of a total of 10,620 trees examined, 368 trees were found to be infected, 338 before the ribes eradication work and 30 afterwards. The work was done during the years 1929-1933. During the years following the ribes eradication work this new infection has amounted to only 0.3 percent. The results of these studies, while not representing the conditions on all areas that have been worked, do represent in general the effectiveness of control work.

In regard to the number of times that an area must be worked to establish permanent control, control has been accomplished on approximately 891,600 acres, representing 52 percent of the worked area, by a single working. The small amount of rework performed thus far does not provide a sufficient basis upon which to determine how many times various areas will have to be worked. In analyzing this problem we must take into consideration the ecological factors influencing ribes growth. The occurrence and distribution of ribes are influenced by fairly definite factors. A logical program of ribes eradication must recognize the fundamental facts that ribes are plant species which appear in the early stages of ecological succession following denudation of forested areas, that their persistence and reproduction are favored by the conditions found in the early stages of such ecological succession, that they are able to persist as component parts of the flora of such forested areas only when the forest stand which follows denudation is relatively thin, and that the only uniform exception to conditions noted above consists of the areas in the stream bottoms upon which conditions for the growth, persistence, and reproduction of ribes are uniformly favorable. On the basis of these facts, areas destined for ribes eradication must be divided into ecological types and treated accordingly. For the Inland Empire such broad types can be recognized and are as follows.

Type 1.—Newly disturbed or denuded areas, upon which the young coniferous stand has only recently started, representing conditions favorable to the appearance and persistence of ribes. In other words, this type represents areas upon which the ribes population is still increasing.

Type 2.—Coniferous stands of pole and merchantable size in which the forest density is so light as to permit the continued growth of ribes. In general within this type the ribes population has reached an equilibrium; that is, these species have established themselves as a component part of the ecological association and are able to maintain themselves in this condition because of general openness of the timber stand. They show little tendency either to increase or to decrease in numbers.

Type 3.—Coniferous stands of pole and merchantable size in which the forest density is so heavy as to preclude the occurrence and reproduction of ribes. In this type it is frequently found that the ribes population is decreasing. No new bushes are appearing, and the old bushes that established themselves upon such areas prior to the closing of the dense timber canopy are slowly dying out. Such areas would normally free themselves entirely of ribes if blister rust would wait, and if there were no small local openings scattered through the stand.

Type 4.—The narrow belt along streams over which the coniferous canopy is broken, permitting the permanent occurrence of brush, and favoring the reproduction and natural increase of ribes.

It should be recognized that the conditions described above are general in character and that frequent local variations will be found. Seed of ribes species occurring in the white-pine forests of the Inland Empire exhibit a remarkable ability to remain viable in the forest floor over long periods, and to germinate and form new bushes when environmental conditions are favorable. This is of primary importance in the case of the newly denuded areas. The greater part of this germination takes place within the first five or six years following the disturbance. Thus in type 1 there is a great variation in the ribes problem depending upon the age of the stand. As this type gets older and gradually passes into type 2 or 3, new ribes become rare or stop appearing altogether.

The degree of persistence of ribes under the conditions represented in the four types and its resistance to eradicative effort determine the working methods and the number of times the ground must be covered before these bushes will be permanently removed. In general, this can be

accomplished only by removing the bushes existing on the ground and by so timing subsequent eradications as to prevent the formation of more ribes seeds. It can be readily seen that the number of workings in the different ecological types will necessarily differ.

Type 1, representing areas on which the ribes population is still increasing, will generally require three workings at three-year intervals before the area is in a ribes-free condition. However, where this type is approaching type 2 or 3 in age, two or even one working may be sufficient. Upon type 2, where the ribes bushes have reached an equilibrium and are neither increasing nor decreasing, it is possible to establish a ribes-free condition with one working. Where the ribes is present in large numbers, two workings may be required because of the resprouts from improperly eradicated bushes. In type 3, where the ribes population is generally light and already on the decline, one working is sufficient to place the area in a ribes-free condition. In type 4, or stream type, since conditions are constantly favorable to ribes growth, a strong and aggressive eradicative effort is necessary to place it on a maintenance basis, and in most cases at least three workings will be required. This type represents only 6 percent of the total area.

The influence of these types is reflected in the results of the control program to date. A single working was sufficient to establish a ribes-free condition on 35 percent of type 1 area, 66 percent of type 2, and 82 percent of type 3.

The classification of areas as to status of control is accomplished by a systematic recording and mapping of all essential information. At the time areas are worked, they are mapped according to type. In place of the four general types outlined above, the areas are classed under twelve different types, according to age and density of the timber stand. The maps show the number and location of ribes plants that were eradicated. Records are kept of the extent and location of fires, logging operations, stand improvement work, and other miscellaneous activities which affect the timber stand and thereby have an effect upon the ribes problem. The size of the units of area upon which these data are kept varies according to the uniformity of conditions. An accurate record of the ribes conditions and the factors influencing their growth make it possible to confine the control work to those areas on which it is needed and to avoid work on areas where the ribes have been successfully and permanently suppressed.

Although considerable progress has already been made in the control of white pine blister rust in this region, at the close of the 1938 season approximately 30 percent of the control area, or about 850,000 acres of valuable white pine lands, will remain unprotected. The amount of pine infection on these lands is rapidly increasing and the extent of the damage is becoming serious. It is now becoming necessary to make a very careful survey of the extent of the pine infection in portions of the St. Joe and Clearwater National Forests to determine the feasibility of undertaking control to save the present white pine crop. Blister rust works slowly in mature trees, and there is evidence that no serious damage will result to these stands over the period in which they will be harvested. The killing action on the immature trees is more rapid. Without control white pine cannot be perpetuated in this region.

In the Inland Empire lumbering is one of the key industries and ranks second in the support of communities. Western white pine is the key tree in this great industry, its value representing about 75 percent of the value of the forest products consumed within and shipped from the region. Without white pine the lumber industry in northern Idaho and the bordering areas in eastern Washington and western Montana would be of little importance. Within this part of the Inland Empire forest industries are responsible for the yearly distribution of some $35,000,000 to $40,000,000 in the region. In the cost of first manufacture of lumber, in northern Idaho alone, the creation and distribution of community wealth in the form of wages amounts annually to about $14,000,000. The government of several counties is dependent upon taxes received from the forest industries, and the forest industries are dependent upon white pine. This region is still faced with a large unprotected acreage as well as a sizable rework program, and the spread of the disease is rapidly outstripping the present progress of the control work. All available resources of the Bureau of Entomology and Plant Quarantine and the Forest Service of the U. S. Department of Agriculture, the forestry authorities of the State of Idaho, and the Civilian Conservation Corps are united in the effort to ensure the future of the forest industries in this region by aggressively pushing the blister rust control program to completion.

MIXED GROUP PLANTING ON THE NICOLET NATIONAL FOREST

By D. K. Maissurow

During the fall planting season of 1936, the Nicolet National Forest initiated, on a large scale, a new method of mixed planting, especially adapted for the reforestation of large tracts. In this method, two or three species of different cover requirements are mixed in groups, the size and location of which are determined by the distribution and density of protective vegetation and by the cover requirements of the species planted. This mixed group planting, as it was called, has now passed the experimental stage and has become a standard method of planting on the forest.

It is generally agreed that the three pines extensively planted in the Lake States, namely, jack, Norway, and white pines, have different cover requirements during the period of plantation establishment. Jack pine can be successfully grown on areas without any cover; Norway pine requires a light cover of about 15 percent crown density, while white pine develops best under a comparatively well closed cover of about 30 to 35 percent density.

Due to these requirements, the selection of planting tracts and the blocking out of plantations, especially in large-scale planting operations, is rather difficult. The difficulty comes from the uneven distribution of cover and marked variations in its density even within areas as small as 20 acres. When mixed planting is not used, such areas are planted to one species, and the predominance of cover of a certain density determines the selection of the species to plant. A white pine site, for instance, with only a patchy growth of thin aspen over 25 percent of its area, is planted to Norway pine, but a similar tract with half or more of its area bearing aspen sufficiently dense for white pine, is planted to white pine. It is obvious that in either case the selection of the species is not silviculturally correct. In the first case, the planting site is graded down because of the insufficient cover and planted to an inferior species, Norway pine, with one fourth of the trees placed under too dense a cover. In the second case, about 50 percent of the white pine trees have not sufficient cover for their successful establishment.

Prior to the introduction of the new method, such planting was the only possible way of treating sites with uneven cover. It was also justified by the general belief that protective cover is not so important as soil and that trees planted under insufficient cover are more or less protected by the adjacent well-covered areas. An analysis of the survival counts for a period of five years, however, has shown that poor survival due to drought, heat, frost, frost-heave, and winter killing was confined primarily to trees planted under insufficient cover. The importance of proper cover in planting pines was further demonstrated by the drought of 1936, which wiped out many acres of pine plantations, affecting, for the most part, trees growing in openings and under insufficient cover.

It was apparent that variations in cover even within small areas required either two or more distinct planting plans or some form of mixed planting in which the selection of species would be determined by their cover requirements. A search for such a method led to the development of the mixed group planting.

The basic idea of the method is that any white or Norway pine planting site lacking a uniform cover is looked upon as a composite site made up of as many distinct and different planting sites as there are gradations, from the planting point of view, in the density of cover. Such a composite site is treated as one mixed plantation, and its composition and the percentage of different species in the mixture are determined by the distribution and density of protective vegetation.

Thus, a Norway pine site—an area meeting pH value and colloidal content specifications for Norway pine—with an intricate patchwork of light aspen stands and open areas free from tree cover is a combination of two sites, Norway and jack pine sites, and is planted to both species mixed in groups. Aspen covered areas are planted to Norway pine; open areas, not affording sufficient protection for Norway pine, to jack pine. On white pine sites, white pine is planted under cover; Norway pine is planted in openings or wherever aspen is too thin for white pine. Jack pine sites, regardless of cover conditions, are planted to jack pine only, for an excess of cover does not justify grading the site a step higher.

The planting of mixed plantations does not require any preliminary blocking out of areas of different cover densities. It is done in one operation, that is, each planter of a planting crew carries two species in his planting box and changes from one species to the other as density of cover changes.

In exceptional cases, badly burned white pine sites are planted to three species. In addition to white and Norway pines, jack pine is planted on areas entirely free from cover. But the character of cover on white pine sites, however, excludes, in the majority of cases, the necessity of using more than two species. Most white pine sites maintain a comparatively dense aspen cover and openings in this cover are usually filled with shrubs and ferns, offering sufficient protection for Norway pine.

The minimum size of openings or areas having thinner cover and requiring a change in species varies from one-fortieth to one-tenth of an acre, depending upon the size and quality of aspen. Small openings sufficiently protected by the surrounding aspen are disregarded and planted to the species of higher cover requirements. The size of groups of one species varies considerably; some groups may be so small as to contain three or four trees only, while others may measure several acres and even "forties."

These groups form a very complicated and intricate pattern, similar, in the distribution of species over the area, to natural mixed pine stands and "pineries," frequently encountered in northern Wisconsin. This similarity is significant silviculturally, for in the formation of mixed pine types, the distribution of two or three species of pine over the area, if seed of all pines is available, is determined by the amount and distribution of cover appearing simultaneously with the pines. Thus, the method of mixed group planting is, in effect, an imitation of the natural processes of reforestation.

Field Planting

The number of trees of each species to be planted in a mixed plantation is figured from "percent cover," obtained during planting reconnaissance surveys. For white pine sites, in addition to "percent cover," an estimate should be made of the extent of the area under heavy aspen, light aspen, and open areas, expressed in percentage of total area. If a white pine site, for example, is made up of 55 percent dense aspen, 40 percent light aspen, and 5 percent suitable for planting jack pine only, then 55 percent of the total number of trees for the plantation will be white pine, 40 percent will be Norway pine, and 5 percent will be jack pine.

Field planting in the mixed group method is not any more difficult than planting one species. Planting boxes are packed with the two species to be planted. Both species are placed in one end of the box and separated from each other with a layer of moss. In case of three species mixtures, the third species is packed in the other end of the box. The foreman in charge of the job estimates the percentage of trees of each species to be planted a day in advance and the boxes are packed in that proportion. As a general rule, however, since a day's work of any planting crew is a good cross-section of a plantation, the original estimate of the percentage of each species in the plantation, figured from planting reconnaissance notes, holds true for the duration of the job. To avoid a possible shortage of stock in the field, a number of boxes of each species is held in readiness for every planting crew.

Since crew foremen and planters are expected to exercise a certain amount of silvicultural judgment in changing continuously from one species to the other, the training of men and crew foremen is an important task, but not a difficult one. The training consists, for the most part, in teaching the men to recognize various densities of cover and change the species as soon as cover conditions change. In the majority of cases, however, the planters are instructed to plant one species in the open, and the other, under aspen. As a rule, new planters, working under close supervision, master the technique of the method by the end of the first day of planting. Errors in planters' and crew foremen's judgment are usually confined to border-line areas between heavy and thin aspen and as such are not important silviculturally.

While it was generally agreed that the new method had a number of merits from a purely silvicultural viewpoint, it was felt that the introduction of the method in the C.C.C. reforestation work might encounter considerable difficulty. It was questionable whether or not inexperienced C.C.C. planters could carry out this new and more difficult method of planting without impairing the efficiency of planting work to the point where the advantages of the method would be nullified by the increased costs. Therefore, to test the efficiency of the new method, a series of

time studies was carried out throughout the forest.

The results obtained differed with the different districts of the forest. But this inconsistency seemed to indicate that differences in soil, cover, topography, experience of planters, weather conditions, etc., had influenced the speed of planting to a greater extent than the new technique involving the handling of two species, a possible shortage of stock in the field, and an added mental effort on the part of the planters in the selection of species to plant. It may be stated, however, with some degree of certainty, that the reduction in the number of trees planted per man per day is almost insignificant. It may amount to 40 or even fewer trees for men averaging about 800 trees a day, but this reduction is easily noticeable only in the work of poor and inexperienced planters. Crews with some experience in straight planting have little trouble with the new method and plant as fast as if working with one species. It is safe to say, therefore, that under proper supervision and in a well organized planting job, the cost of field planting per acre is not any higher than in planting one species.

Mixed group planting can be used for a variety of species and sites. Mixed white spruce and Norway pine plantations can be successfully established on white spruce sites. White spruce, requiring considerable protection in its early stages, is planted under cover; Norway pine—in openings. A number of such plantations were established on the Nicolet National Forest. The method was also tried in re-planting one species plantations established without reference to cover requirements of the species. White pine plantations, for example, were re-planted to white pine and Norway pine, with the latter placed on areas without sufficient cover for white pine.

Some Advantages of Mixed Group Planting

The advantages of mixed group planting may be summarized as follows:

1. By planting in accordance with the cover requirements of the species, better survival and growth are secured.

2. The method results in the formation of mixed forest.

3. The cost per acre of plantation establishment (reconnaissance, planting, re-planting, and care of plantations) is lower in mixed group planting than in straight planting. The reduction in the cost is effected by (a) fewer re-plantings due to better survival, (b) by lower cost of high release work due to the fact that trees are seldom planted under excessively dense cover, and (c) by low costs of surveying and staking out plantations, for even large tracts can be planted to two or three species without costly blocking out of areas of different cover densities.

A certain loss in the value of the future crop because of planting inferior species, such as Norway and jack pine, on white pine sites is compensated for by the lower cost of plantation establishment, and by the better height and diameter growth of these two species when planted on better soils and under proper cover. It should be kept in mind, however, that the use of jack and Norway pines on white pine sites is practiced to a much lesser extent in the mixed group method than in straight planting, for in the majority of cases white and Norway pine areas are at least 60 percent covered with aspen sufficiently closed for planting the species called for by the soil. The use of jack pine on white pine sites is also justified by the fact that white pine trees planted in the open are likely to be deformed and unsuitable for little else but pulpwood.

Survival counts for mixed plantations established in the fall of 1936 and in the spring of 1937 have shown a considerably higher percentage of survival than in previous straight plantings of the same species. This, coupled with the other advantages of the method, warrants its further use and development.

PUBLIC FOREST REGULATION IN MEXICO

By HANS ARTHUR MEYER
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With increasing discussion of the public interest in forests, irrespective of ownership, as justification for public control it is worth while to consider progress in this respect in an adjoining country. Mexico has fairly exacting government restrictions to control cutting on private lands. This article describes these regulations and comments on the extent to which they are enforced. The author's opinion is based on two years' service in the Mexican Forest Service.

THE place of public regulation in European forestry is generally recognized. Our forest policy has not yet resulted in the establishment of the public regulation which has proved so successful in central Europe, chiefly because of the difference in political and economic conditions. The basic principles of public regulation, however, are advocated in this country, although the methods of practical application must be different. In considering the approach to a form of public regulation, we may find it interesting and challenging to follow the developments in a neighboring country, where conditions are in many respects similar, or, when they are different, even more adverse to successful forest regulation than in the United States. Curiously enough, not a single note on the Mexican federal forest law has ever been published in the JOURNAL. A detailed discussion of the *Ley Forestal y su Reglamento* would probably be interesting to many American foresters or representatives of the lumber industry. The following explanation of this law will be confined to those articles which are more or less directly concerned with public regulation and which are therefore of special interest at a time when this important question is being considered in this country.

All forests regardless of ownership—national, communal, corporation, and private—are subject to the forest law. In rather general terms it is stated that the exploitation of the national reserves must strictly follow a previously established management plan which guarantees the sustained conservation of the forest vegetation. The exploitation of communal and corporation forests is subjected to the ordinances which shall be given by the Secretary of Agriculture (today by the Department of Forestry, Game, and Fish). Exploitation in private forests is allowed upon a special permit to be secured from the Department of Forestry, which shall determine the rules that must be followed.

Passing over the chapters on reforestation, protection, forest diseases, forest fires, and the organization of the Forest Service, I cite Section I of article 47, concerning forest taxation. Forest owners subject to forest taxation "shall not pay any taxes on the value of the growing stock as long as they do not exploit it." The forest taxes as provided by the new law on forest taxation of 1936 are all yield taxes.

In the by-law the previously outlined prescriptions are further detailed. This by-law is especially interesting, because it tells how the forest law has to be applied and enforced in practice.

The preliminaries which must be met before any permit of exploitation[1] is granted vary somewhat for the different classes of forests and ownership and the kind of exploitation contemplated. For the exploitation of the national reserves these prescriptions are, principally, the same as those which govern the policy followed in the exploitation of the national forests of the United States. They are therefore not considered further in this connection.

In communal forests and *Terrenos ejidales* (distributed forest lands to be managed on a cooperative basis) only the removal of dead timber is allowed without a permit. The exploitation of all other products must be authorized by the Department of Forestry. Exploitation of a commercial character may be carried out only after a provisional or definite management plan, made by a technically trained forest engineer, has been established and subsequently approved by the Forest Service.

The exploitation of private forest lands is al-

[1]"Exploitation" as used here is the most literal translation of the word *explotación*. The nature of the law obviously implies orderly and conservative cutting practices. As a matter of fact, the law requires that the management plans state definitely how many seed trees above a certain diameter limit must be left on the ground.

TABLE 1.—REQUIREMENTS TO BE MET BY OPERATORS AS DETERMINED BY VOLUME OF EXPLOITATION

Requirements	Volume of exploitation and products				
	Wood			Resin	Chicle
	Fuelwood	Saw timber			
		From temperate and cold regions	From tropical woods		
		m^3	m^3	*tons*	*tons*
None	Dead wood				
Single permit to be secured from local official of Department of Forestry	192 cords a year				
Inspection by official of Department of Forestry	270-500 m^3	up to 100	up to 50	up to 20	up to 5
Definite written statement concerning contemplated exploitation, made by professional forester		100-2,500	50-1,000	20-75	5-20
Provisional plan of exploitation (simple management plan)		2.500-5,000	1,000-2.000	75-300	20-100
Management plan		5,000 and over	2,000 and over	300 and over	100 and over
Management plan and permanent employment of professional forester		15,000 and over	1,500 and over	1,000 and over	200 and over

1 m^3 = 35.3145 cubic feet.

lowed only after a special permit has been obtained from the Department of Forestry and it must be carried out in accordance with well-defined regulations, of which the following are mentioned. Small owners and poor people may exploit forests for domestic purposes after securing from the local forestry official a simple permit to cut branch wood in quantities not exceeding four cords a week or 192 cords a year. After a special inspection, to be made by an official of the Department of Forestry and paid for by the owner, larger quantities of wood may be cut. The accurate figures are shown in Table 1. A definite written statement, made by a trained forester, concerning the kind and quantity of wood to be cut, is necessary for operating on a larger scale. For the cutting of 2,500 to 5,000 cubic meters of timber (logs) a provisional plan of operation, which is actually a simple management plan, is required. For larger enterprises definite and detailed management plans must be undertaken and completed during a period of not more than five years. In the meanwhile a preliminary report is accepted for issuing the necessary permits. Finally, large commercial forest enterprises are required to employ during the whole operation a trained forest engineer who is responsible to the government to see to it that the cutting is carried out in accordance with the provisions made in the management plan.

These prescriptions appear very progressive from the standpoint of public forest regulation, especially when compared with the situation in the United States. The reader will naturally ask, are these regulations actually put into practice? Is the law actually enforced? While employed by the Mexican Forest Service during a period of two years the writer had ample opportunity to be convinced that the law was enforced except in remote regions of the country where all communication facilities are lacking and where the Indians still live their primitive life of centuries ago, burning annually large areas of forest land in order to raise corn on a soil enriched by the ashes of the burned vegetation. There are, however, no commercial operations in these regions. Great progress has been made since 1934, when the Mexican Forest Service became an autonomous department headed by the father of Mexican forestry, Ing. Miguel A. de Quevedo.[2] The extent to which the government has actually extended its control over the exploitation of the forests is best reflected by the increasing income from forest taxation in the last few years. For comparison the receipts and expenses of the Department of Forestry, Game, and Fish are shown in Table 2.

[2]An outline of the six-year program of the Mexican Forest Service appeared in the JOURNAL in February 1935.

TABLE 2.—RECEIPTS AND EXPENDITURES OF THE DEPARTMENT OF FORESTRY, GAME, AND FISH

Year	Division of Forestry	Income Division of Game	Division of Fishery	Expenses
	Pesos	*Pesos*	*Pesos*	*Pesos*
1929	----------	129,833	868,567	....
1930	----------	86,775	823,730	..
1931	42,792	56,818	373,429	
1932	49,440	53,732	575,353	....
1933	105,390	59,188	483,625	....
1934	153,532	36,328	431,980	----------
1935	445,496	41,999	664,002	2,346,533
1936	3,437,363	69,068	967,005	2,776,035
1937	4,764,890	111,709	1,618,552	----------

1 peso = $0.20 approximately, varying with the price of silver.

A word may be said concerning the status of the Mexican forest engineers. Mexico has its own trained foresters, though not yet in a number sufficiently large to insure proper management and control of all the forests of the country. The first Mexican forestry and ranger schools date back to the beginning of this century. All practicing foresters, regardless of whether they are employed by the government or by private companies, must be registered and licensed by the Department of Forestry. The men who are working for the private industries as "responsible foresters" are supervised by federal inspectors and they may be disqualified and the operation suspended if not carried out according to the approved management plans.

REDUCTION OF SPRUCE AND FIR LITTER BY MINUTE ANIMALS

By ARTHUR PAUL JACOT

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The old idea of complete reduction of litter by inorganic chemical changes has proved erroneous. Various reducing agents, the best known being bacteria and fungi, subsequently have been studied. The following article describes how a few out of the host of species of minute animals of the forest floor contribute to the reducing process.

TO REPRODUCE themselves, forests are largely dependent upon seedlings. Spruce seedlings cannot grow and thrive if soil water is not constantly available within reach of the seedling's one or two-inch root system. Soil water may be isolated from the roots of young seedlings by a deep litter layer. Thus it is imperative to control the depth of litter accumulation. This can be done by encouraging decay of the litter. Spruce litter is reduced by the action of fungi, animals, and possibly bacteria.

Since reduction by animals can be controlled at least to the extent of introducing them in woodlands where they have been exterminated by fire, an attempt was made to determine what species of animals function as spruce litter reducers. As far as is known animals do not eat dry and seasoned spruce and fir needles. After fungi have softened and somewhat predigested the needles, animals are able to operate upon them. Two types of feeders may be recognized: *endophages* which eat the needles from the inside, and *ectophages* which eat the needles from the outside,—much as we eat up a loaf of bread, or mice nibble into it. Since nothing definite is known of the ectophages, the present account will be limited to the endophages.

These studies were carried out at the Gale River Experimental Forest in northern New Hampshire. The litter examined was taken from a tract of undisturbed spruce flat type with yellow birch intermixed (*4*). There is no evidence that this tract has been burned over, at least for hundreds of years; the fauna has had ample time to become stabilized. In such a tract the humus forms a layer seven to occasionally fifteen inches deep. This is overlain by a layer of dry and of decaying spruce and fir needles about one inch deep. It is in this relatively shallow upper layer that the spruce and fir needles are reduced to faeces which form the bulk of the humus layer.

When spruce and fir leaves fall to the ground they are very quickly attacked by various fungi which break down the contents and structure of the needles. The most conspicuous of these

fungi, which seems to be *Lophodermium piceae* (Fückel) Höhnel[1] (*1*), reduces the internal structure of the leaf to a remarkable degree, leaving but a few filaments of tissue. It is also notable in that it operates on an even front forming a conspicuous black wall which extends as a definite flat barrier across the entire width and height of the leaf. This black transverse wall, one at each end of the disintegrating area, is noticeable on the outside of the leaf. Such a condition is accompanied on the surface of the leaf by a black, carbonaceous, oval pustule of considerable size, which splits open lengthwise. Animals living in such a leaf never break through the black wall and are never found between the walls.

A type of reduction common to fir needles leaves them very watery and thin, so that in a digested leaf the midrib and the lateral pitch rods stand high above the intervening tissues, like the bones of an emaciated animal.

As soon as the needles have been partly softened by fungi the animals are able to insert their ovipositors and lay their eggs which soon hatch into larvae. The larvae of at least four minute animals thus begin life within the walls of these small resinous needles; three are mites and one is a midge (Sciara). The mite larvae are short, white, and six legged. The midge larvae are long, cigar-shaped, and without legs.

As the mite larvae eat the palisade tissue immediately about them, they advance into the cleared area and deposit their oval, brown faeces in a pile behind them. When the larva is fat and stout it stops feeding to moult and thus acquires a much larger skin and a fourth pair of legs. It is then known as nymph I. Its cast suit lies behind it and soon becomes unrecognizably crumpled among the ever increasing pile of oval faeces. Only the mandibles and maxillae which are very heavily sclerotized, remain unchanged to mark the point of moult. After a period of feeding and fattening, nymph I moults to become the larger nymph II, which feeds and moults to become nymph III. At each moult certain additional structures, chiefly bristles are acquired. Thus it is possible to identify each nymphal stage by the bristles borne by the incumbent. By the time nymph III has reached the further end of the leaf it moults again to appear as a hard, brown, adult much resembling a minute beetle. The adult now cuts a hole in the epidermis, and steps out to search for a mate. As adults lay eggs all through the spring and summer, larvae, and nymphs in all three stages may be found throughout the growing season. This overlapping of life cycles insures more continuous and much greater needle reduction.

It is interesting to note that one species of mite (*Hoplophorella thoreaui* (*2*) (Fig. 1) is characteristic of spruce needles though also found in the short stout fir needles. Another species (*Phthiracarus boresetosus* (*2*) is characteristic of the flat fir needles. The egg is usually laid in the proximal end of the fir leaf, possibly through the attachment disc, and the mite eats its way down the ever broadening needle. The third species (*Adoristes ovatus ammonoosuci* (*3*) is found in both spruce and fir needles though it is not as common as the other two mites. Fir needles may be found which harbor two mites, each keeping to its own side of the midrib. It is possible that the mites *Steganacarus striculus diaphanus* and *Phthiracarus compressus* (*2*) similarly develop in spruce and fir leaves,

Fig. 1.—*Hoplophorella thoreaui*. (Upper) Adult. Much enlarged (natural size about 1/50 inch). (Lower) Nymph II, in spruce leaf (broken open).

[1]Determined by Alma M. Waterman through Dr. Perley Spaulding, of the Division of Forest Pathology.

but they were not common enough in the needles examined to be able certainly to identify them in the immature stages.

The midge larvae (Sciara) are not as common as are the mites and they are usually found in needles which are much more decayed (by fungi). It is not certain if the egg is deposited in leaves containing mite faeces which the midge larva then feeds on, or whether the larva feeds on undisturbed tissue. It is often found in a leaf with one or two saprophagous mites or their faeces. From needles of a sample taken July 26th were obtained full grown larvae, pupae, and leaves from which the adult had already escaped. The leaves in which these larvae were found (on July 26th) were much more decayed, softer, flabbier (flaccid), paler, than those which harbored the mites. In other words, by the time Sciara transforms to adult, its leaves are much more reduced (decomposed) than are the leaves of the mites when they transform to adults. Thus there is reason to believe that the midge feeds on the faeces of the mites, further reducing them to a fine granular substance which would be much more easily washed into the soil by percolating rainwater.

All three of the mites are to be found in the needles from spring to autumn, their adults being common in litter samples all year. The fly larvae emerge as adults near the end of July, so they may have a second brood which may overwinter as eggs. Other mites were found in the needles but they may have entered them through exit holes to eat the faeces.

Nematodes as long as half the width of the leaf (fir) occur not infrequently. One fir leaf taken May 19th contained several such nematodes among Phthiracarid faeces.

Both the mites and the midge leave their cradle with the epidermis almost intact. Similarly the above noted fungi leave the epidermis wrapped about the few internal fibers. The further reduction of these fibers, the faeces, and the epidermal envelopes, forms an unopened chapter in the story of reduction.

As these animals begin only when the needles are partly softened, they are not found in the uppermost leaves of the litter and are irregularly distributed below them so that it is difficult to estimate the percent of needles which they reduce as compared to reduction by the fungi. Moreover the efficacy of the endophages will vary widely in each locality and condition of the forest floor depending on the number of species of endophages present, the moisture, the degree of shade, degree of trampling, and related factors. Since they spend their entire cycle in the litter layer, a forest fire would wipe them out. Then when the new stand begins growing on the old burn, the mites might not come into the stand for several years,—thus accounting for the local distribution of some of these species, and possibly for differences in the rate or course of spruce-fir litter reduction.

Summary

Spruce and fir litter of northern spruce woods was found to be reduced by the immature stages of three species of saprophagous mites which eat the needles from the inside. Due to overlapping of generations, these mites feed throughout the growing season in leaves which have been softened by fungal action. A species of midge (Sciara) was also found within the needles but there is evidence that it may be a secondary saprophyte. Nothing is at present known of the ectophages of spruce and fir needles.

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COORDINATING PLANS FOR FIRE PROTECTION FACILITIES

By WILLIAM G. MORRIS

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The author here describes an attack on a very timely and important problem. If a fire administrator wants to obtain maximum protection from fire on a forest unit at the least annual cost, what should he do: build more lookouts? construct more roads and trails? or put more fire guards or fire fighters in the area? The author assumes, as has often been suspected, that no one set formula will apply everywhere. Accordingly, for a particular ranger district in Oregon he tries in turn to determine what the effect would be of concentrating only on one formula and measuring the result in terms of both the cost of the facilities and the average number of fire fighters it would probably take per fire; he then concentrates on another; then on combinations of both, etc. He uses the results as a measure of the relative desirability of the different combinations.

FOR successful protection of forest lands against fires, provision must be made to detect fires when they occur, to place fire fighters in the most strategic locations and for the development of a system of roads and trails that will enable fire fighters to reach the fires quickly enough to keep losses to an acceptable maximum.

In making these advance preparations, the forester must coordinate each class of facilities with the facilities in every other class to give the required protection at the least cost. If, for example, in a given area the topography is too rough to prevent adequate detection coverage by lookouts at a reasonable cost, with the result that the size of fires when discovered is likely to be too great for suppression by 1 or 2 men, and if losses can be kept to an acceptable minimum by slower attack with a large force, then roads and trails into the area may be more economical and effective than complete coverage by lookouts. In another case with fuels similar to those in the first example, if the topography allows direct visibility of most of the area by lookouts at a comparatively low cost, with the result that the small size on discovery will allow suppression by 1 or 2 men, then trails and complete coverage by lookouts may be more economical than a road into the area. Evidently an increase in one class of protection facilities may allow a decrease in another and still produce the same net result. Satisfactory procedures of planning transportation (*7, 8, 12*) and detection (*5, 6, 13*) have been developed, but a method of correlating these is needed. A method of correlating that has been tried experimentally[1] on a sample ranger district in Oregon will be described.

A measure of the advantage gained by an increase in one class of fire protection facilities while the others remain at the same level is necessary in order to plan each one so as to get the most protection for the least cost. One measure of the advantage of an increase in a given class of fire control facilities is the minimum size of crew or strength of attack required to corral a fire with the proposed facilities compared with the strength of attack required without the increase in facilities. A counterpart of minimum required strength of attack is cost of facilities. Hence the relative desirability of different combinations of intensities of development in detection, transportation, and firemen[2] placement was measured in terms of resulting strength of attack required and in terms of cost.

Standards Used

The strength of attack required, besides depending on the physical conditions of rate of spread and resistance to control of the fuel type, depends on the time that the fire can be allowed to burn before corralling it and still keep the loss to an acceptable maximum. It has been said (*10*) that the losses as compared with costs can be kept at an economic balance if 98 percent of all fires are corralled before approximately 10 a. m. (the time when fires usually begin to burn faster) of the day following discovery. The Chief of the U. S. Forest Service has adopted this 10 a. m. corral as the objective for fire control administrative action. Hence, in determining the strength of attack necessary under a given set of physical condi-

[1] In cooperation with the Regional Forester's Office of Fire Control, Portland, Oreg., and with the assistance of C. G. Herold, V. E. Hicks, H. A. Rapraeger, V. C. Stevens, and J. R. Stevenson.

[2] "Fireman" as used in this article designates the duty of going to a fire and attempting to corral it when it is discovered either by the same or by another person. The fireman, in addition, may have other duties such as detection and prevention.

tions, we assumed that the fire must be corralled by 10 a. m. of the day following discovery. In addition, for the purpose of comparing the strength of attack required under rather severe conditions, it was assumed that all fires would be discovered at noon on a day when the visibility is equal to that of the worst one-third of the days, and when burning conditions are equal to the average of the worst 40 percent of the days.

The General Procedure

The general procedure in applying this proposed method of determining the most desirable combination of detection, transportation, and guard placement on a ranger district is to start with the hazard or fuel type map of the area to be protected and a map of the present protection facilities. From these the size of crew or the strength of attack required (under the assumed conditions listed above) on each unit area of the ranger district is then compiled and indicated on a map. Similar maps are next constructed for other combinations of facilities. For example, one may be constructed assuming that the number of lookouts has been increased by one-third through a system of careful selection for maximum coverage from that number, but assuming that the present road and trail system is used. Another may be constructed assuming that all practicable road locations are developed so as to intensify the network, but assuming that the present lookouts are used. Another may be constructed assuming that both the lookouts and the roads are increased. Other maps may be constructed assuming that less than the present number of lookout points are manned, or that twice as many guards are placed at strategic points for suppression work. Annual cost per acre, including maintenance, depreciation, and salaries of lookouts and guards, is then computed for each combination of facilities for which a strength-of-attack map was made.

The strength of attack required and the cost for each combination of facilities are next studied to determine which combination is most practicable. The strength-of-attack maps will usually be composed of too many different areas to allow easy and accurate direct comparison, and so the important information on a map may be summarized by computing (1) the average strength of attack per acre required for the ranger district as a whole, and (2) the percentage of the ranger district requiring a relatively large strength of attack, as, for example, over 150 men. On the basis of cost and strength of attack required for the district as a whole it will probably be found that some of the combinations of facilities cost a great deal more than others, but do not reduce proportionately the required strength of attack. These combinations will obviously be rejected. Other combinations may be about equal in cost but unequal in required strength of attack. One combination can probably be selected which will be practicable in cost and reasonable in the strength of attack indicated to be necessary.

Suppose, for example, that for a combination of a high intensity of detection service, a high intensity of road and trail development, and a moderate intensity of fireman manning, the required average strength of attack over a certain district as a whole will be 30 men and the average cost per acre per year will be $0.10. Suppose also that for a combination of a moderate intensity of road and trail development and a moderate intensity of fireman manning the required average strength of attack will be 33 men and the average cost per acre per year will be $0.06. Then the latter combination would probably be chosen because it costs only 60 percent as much as the former and requires only a 10 percent greater strength of attack.

The studies of the strength of attack required over the district as a whole for the different levels of development and their cost yield a first approximation of the actual plan of development of new facilities. The next step is to make a more precise estimate of the need of particular facilities within the general level of development so selected. Detailed studies should be made to determine which lookout points should be manned to give the best detection coverage with the number of points that will be available. Likewise the particular road and trail locations that will give the best travel-time coverage for the level of development decided upon should be selected. The details of methods appropriate for selecting lookout points and transportation routes will not be discussed here.

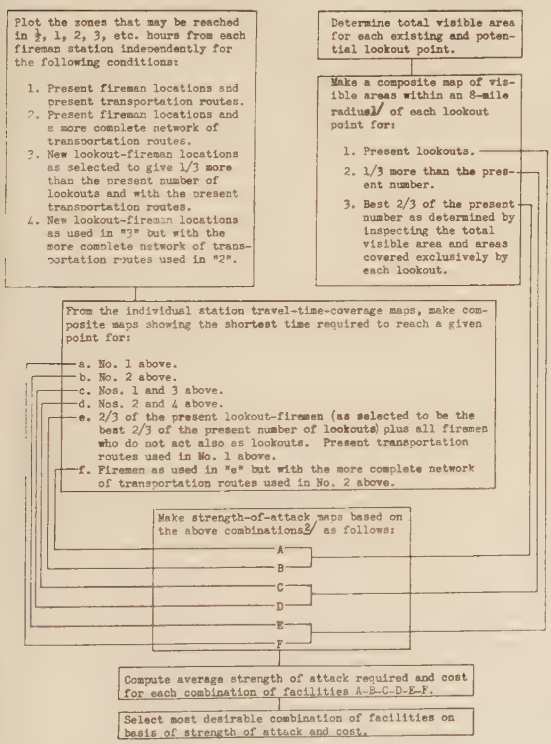
Details of the Procedure

The foregoing discussion outlines the general procedure. Additional details concerning the preparation of the strength-of-attack map follow.

The essentials in determining the strength of attack required to corral a fire in a given area

by 10 a. m. of the day following a noontime discovery are: (1) determine the perimeter that a fire may attain before it is discovered; (2) determine the probable rate at which the perimeter will increase under the assumed weather conditions; (3) determine the perimeter that will be added in the interval from discovery to arrival of the crew necessary to corral it; (4) determine the amount of held fire line that can be constructed per man-hour of work; (5) knowing the rate of perimeter increase and the rate of fire-line construction, compute the number of men required to corral the fire in the given allowable working period.

It is evident that the required strength of attack may differ for a fire starting on each area that has a different combination of probable size on discovery, rate of perimeter increase, time interval between discovery and arrival of the suppression crew, and rate of line construction. Hence maps are made on tracing paper to show each one of these variable factors separately for



[1]The limit of safe visibility due to haze during 1/3 of the fire season.

[2]Where the strength of attack required is greater than 3 men the travel time from the district headquarters is used instead of the composite travel-time-coverage maps.

Fig. 1.—Sequence of steps in the planning procedure.

the entire ranger district, and then by overlaying the maps and tracing the boundaries of different combinations of these factors the areas are outlined that will require a given strength of attack determined by the computations.

Certain preliminary studies must be made to obtain the information necessary for the maps of probable size on discovery, time interval between discovery and arrival of the suppression crew, probable rate of perimeter increase of a fire under the assumed weather conditions, and amount of fire line that can be constructed per man-hour of work. Probable size that a fire may attain before discovery may be determined by a study of individual fire discovery records of a large number of lookouts and other discovery agencies over a period of several years. For regions having rough topography the study might distinguish between fires discovered in areas directly visible to the lookout and those not directly visible (blind areas) because of intervening topographic features. For localities in which local residents or passers-by are depended upon for reporting fires the study might distinguish between fires discovered in areas directly visible to routes of frequent travel and those not directly visible. Average time interval between discovery and dispatching of the suppression crew may be determined by a study of records of previous fires and by the judgment of experienced fire executives.

The time interval from a given station to a given fire location can be determined by applying to a map of the travel routes the rates of travel which experience has shown to be about average for the available classes of roads, trails, and cross-country travel. These travel times may be plotted mechanically and shown in zone form on a map to indicate all areas that may be reached in ½ hour, 1 hour, 2 hours, etc., from a certain station (*11, 12*). Then a composite travel-time-zone map may be traced from the combined maps of individual stations to show the shortest time required to reach any given area in the ranger district.

Probable rate of perimeter increase of a fire at a given point in the ranger district under the assumed weather conditions can be determined from a map on which the fuel types are classified (*1, 2, 3, 4, 9*). The rates of fire spread in units of perimeter increase per hour to be expected in the different types may be based on a study of individual fire records if suitable records are available or on a field study of fires burning in the various types. Likewise the amount of fire

line that can be constructed per man-hour of work in a given area can be determined from a map on which the forest cover and debris are classified especially for the purpose. The rates of line construction per man-hour to be expected in the different types may be based on a study of individual fire records if suitable records are available or on a field study of work rates in the various cover types.

An explanation of the method of computing the required strength of attack for a given set of conditions after the above preliminary studies are made is not essential to an understanding of the proposition that the required minimum strength of attack and cost of accompanying facilities can be used as a measuring stick in coordinating plans for detection, transportation, and fireman locations. But since it may prove puzzling to omit this step entirely from the discussion, the method used experimentally on the sample ranger district in Oregon will be given. For comparative purposes the following conditions were assumed to be constant: fire discovery at noon, average discovery and report time as found by the dispatching time study, no perimeter increase between 7:30 p.m. and 10 a.m., 5 hours of working time on the fire line either the first afternoon or the next forenoon before 10 a.m. or both together (depending upon the time of arrival at the fire), rate of perimeter increase during the corral period to be gradually reduced by attack on the faster-spreading parts and the resulting rate of spread for the fire as a whole during that period to be one-half of the estimated rate of spread of an unchecked fire as shown by the fuel-type map.[3]

It is not expected that a large proportion of the actual fires will fit the pattern of standard conditions that are assumed. But this does not invalidate the determination of required strength of attack as a measuring stick for comparing the advantages and disadvantages of different combinations of various intensities of development in detection, transportation, and guard-placement facilities. It is only necessary that the measuring stick be the same for each different combination of facilities and that it indicate with sufficient clearness any important differences in magnitude. The measurements can then be compared to determine their proportional or relative differences regardless of the units of measurement used. For example, if the measurements show that one combination of facilities will make it necessary to use an average strength of attack of 24 men for the district as a whole while a second combination will make it necessary to use a crew of only 12, then the second combination of facilities will require one-half as great a strength of attack as the first, regardless of whether it is found later in practice that the actual numbers are 26 and 13, or 30 and 15, or any other 2 to 1 ratio.

The necessary strength of attack on a fire at a given point in the district can then be computed from data obtained in the preliminary studies as follows:

1. The job to be done or perimeter to be corralled depends upon:

a. Perimeter on discovery.

b. Perimeter increase during the period from discovery to arrival of the suppression crew.

c. Perimeter increase during the period from arrival to corral (or until 7:30 p.m. if the time of arrival will not allow the 5-hour working-time limit before 7:30 p.m.).

2. The rate of doing the job is the rate of line construction per man hour.

3. The time to do the job is 5 hours.

4. The number of men required is given by the perimeter to be corralled divided by the rate of line construction and by the limitations of time in which the job must be accomplished.

Outline of Procedure in Application

To illustrate the relationship of the various steps in making the necessary strength-of-attack maps in practical application, the following outline of the working materials and the diagram of the sequence of steps used on the sample ranger district in Oregon are given.

The working materials already available based on previous studies were: (1) a fuel-type map of the district; (2) maps showing areas of direct visibility for each existing and potential lookout; (3) average travel rates on each road, trail, and cross country in each part of the district; and (4) a table showing the required strength of attack for fires in blind and visible areas, different fuel types, and for different periods of unchecked spread between discovery and arrival of the suppression crew.

The system proposed for coordinating the plans for detection, transportation, and guard-placement facilities in forest fire protection has been outlined in a general way so that the principles rather than the details may be considered. The essence of the method is that the desirability

[3]This hypothesis was also used by Abell (*4*).

of a given increase in intensity of development of detection, transportation routes, and fireman placement can be measured by the cost of the new facilities and by the average strength of attack required on an administrative unit to corral all fires under a given set of weather conditions. Thus the object is to find the combination of facilities which will give the most protection for the least money. Only by planning all facilities on a coordinated basis can this objective be reached. Therefore the advantage of using this method is that it will result in a balanced system which will provide the maximum amount of protection for the money expended.

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Map of Canadian and Paper Industries

CANADA has ninety-nine pulp and paper mills, according to a new map of the pulp and paper industries of Canada and Newfoundland, prepared by the Dominion Forest Service, Department of Mines and Resources, Ottawa. This new map not only shows the locations of the various mills and the addresses of their head offices, but it also lists the various products manufactured at each plant.

Canada leads the world in the production of newsprint paper, and exports more newsprint than all other countries combined. The pulp and paper industry is Canada's most important manufacturing industry.

THE APPROACH OF LOBLOLLY AND VIRGINIA PINE STANDS TOWARD NORMAL STOCKING

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"What difference does it make?" This question has often been asked by foresters, armed with normal-yield tables, confronted with the problem of predicting growth for nonnormal stands. Recognizing the fact that understocked stands tend to increase in stocking, but lacking the information necessary to adjust the growth estimates, foresters have generally disregarded changes in stocking caused by approach toward normality. This paper indicates that the failure to account for such changes may lead to serious errors in growth predictions obtained through the use of yield tables.

FORESTERS have long recognized the limitations of so-called normal growth and yield tables when applied to abnormally stocked stands. The usual practice of estimating the growth of under and overstocked stands has been to compute the existing degree of stocking as a ratio of normal or yield table values and apply this ratio to normal yield table values. A growth estimate so obtained has usually been considered conservative by an uncertain, but probably negligible amount—conservative because of the tendency of forest stands, most of which are understocked, to approach normal conditions of stocking with the passage of time.

This approach toward normal stocking occurs because competition among trees is less severe in understocked than in normal stands, resulting in greater individual tree growth, a smaller loss due to mortality, and a trend toward more complete utilization of site. Conversely, the effect of the more severe competition in overstocked stands results in decreased growth of individual trees and increased mortality until the stand comes into equilibrium with the site and normality is attained.

But it has been argued that although changes in stocking may occur, the rate of this change is slow and may be disregarded for short-term growth predictions. Meyer (*6*), in preliminary attempts to determine the rate of approach toward normality, estimated that a stand of Douglas fir, 80 percent stocked, will increase in stocking at the rate of 4 percent over a 5-year period. Although this indicates a rather minor change in degree of stocking, it represents a considerable difference in actual growth in terms of cubic volume. Applying Meyer's figures to the Douglas fir normal yield tables (*7*) for stands 80 percent stocked and 50 years old on Site Quality II, the growth for the next 5-year period, not taking into account change in stocking, is 808 cubic feet. If a 4 percent change in stocking is assumed, the growth for the 5-year period is 1,202 cubic feet, an increase of 49 percent—a very real difference in growth.

Gehrhardt's Formula

A method of estimating the rate of approach toward normality, commonly used in Europe, has been devised by Gehrhardt (*2*). To some extent this method has been applied to northern hardwood stands in the Lake States (*1, 3, 4*). Although Gehrhardt's formula is comparatively simple in application and has apparently yielded satisfactory results in Europe, it has some inherent qualities which limit its usefulness. These limitations may best be shown by the following illustration. Briefly, Gehrhardt's formula applied to a given understocked stand is:

$$g = dG\ (1 + K - Kd),$$

where g = growth of the understocked stand during a 10-year period, d = density of the understocked stand at the beginning of the period, G = growth of a normally stocked stand during the period, and K = a constant for any given timber type, ranging from approximately 0.6 to 1.1 depending upon the tolerance of the species. Applying Gehrhardt's formula to loblolly pine, selecting 0.9 as K representing medium tolerance, the equation becomes

$$g = dG\ (1.9 - 0.9d).$$

Table 1 shows the computations in the solution of g for stands of different densities, the determination of densities at the end of the 10-year period 45 to 55 years of age, and the changes in density taking place during the period. These changes in density are plotted over the original densities of the stands, as shown by the lowest curve in Figure 1. Changes in

density are similarly computed for three other age periods and plotted in Figure 1.

Two elements of interest are exhibited by the curves in Figure 1. First, there is a correlation between change in density and age of stand; that is, for a given stocking a young stand will change in density more rapidly than an older stand, except, of course, at 0 and 100 percent stocking. Second, the curves display a definite symmetry; that is, they are symmetrical about the point of maximum ordinate, or at 50 percent stocking. The first element is in accordance with any rational theory of approach toward normality. However, the second element, that of the symmetry of curve-shape, is difficult to reconcile with the present knowledge of trends toward normal stocking. This condition offers an objection to the use of Gehrhardt's formula, for there is no reason to believe that the greatest change in stocking occurs when a stand is 50 percent stocked. Furthermore, it seems unlikely that a stand 20 percent stocked will increase in density at exactly the same rate as a stand 80 percent stocked.

Although neither Gehrhardt's formula nor Meyer's correction adequately solves the problem of estimating the rate of approach toward normal stocking, they do represent definite contributions to the recognition of the problem. The final solution for determining the exact rate of change under all conditions may lie in periodic remeasurements of numerous permanent sample plots. However, this paper offers a device whereby preliminary estimates can be made available for current use.

The Theory and Method

If it is true that degree of stocking changes with advancing age, it follows that a greater percentage of the older uncut, undisturbed stands are more nearly normally stocked than younger stands. Also, it is reasonable to expect that at some high, indeterminate, and perhaps variable age, all untreated stands will be normally stocked. Furthermore, one would expect to find young stands representing, in addition to normal stocking, different degrees of understocking and overstocking—a much greater dispersion of densities than in older stands.

If a random sample of untreated forest stands of a given species is chosen, it is probable that the average degree of stocking for each age class would be correlated positively with age. To establish the existence of this relationship, sample stands must be even-aged, uncut, with little disease, insect, or fire damage, and with a reasonably uniform distribution of trees within the stands.

Two sources of data meeting these specifications are available: 144 loblolly pine (*Pinus taeda*) temporary sample plots were mechanically selected in the mid-Atlantic coastal region, and 162 plots of Virginia pine (*P. virginiana*) were similarly selected in the mid-Atlantic Piedmont region. For loblolly pine the measure of stocking was expressed as a percentage of the actual number of trees per acre of all species to the number expected in fully stocked stands of the same average diameter. In fully stocked stands of loblolly pine

$$N = 14{,}415\ (\text{d.b.h.})^{-1.7070}$$

Where N is the number of trees per acre in fully stocked stands and d.b.h. is the average diameter breast high of the stand (5). For Virginia pine the measure of stocking was expressed as a percentage of the actual basal area in square feet per acre of all trees to the basal area expected in stands of good stocking of the same age and site index. In well stocked stands of Virginia pine

$$\text{Logarithm of basal area} = 2.0827 - 4.0051 \left(\frac{1}{\text{age}}\right) + 0.0029\ (\text{site index}).$$

Figure 2 shows the average density of stocking for even-aged stands of undisturbed, second-growth Virginia and loblolly pines. The trend toward increasing density of stocking with increasing age is clearly shown. The shape of the curves also indicates that stocking increases more rapidly in the younger than in the older age classes and that the increase is most rapid when density is low. Thus two principles may be established; the rate of change in stocking is dependent primarily upon 1, the initial stocking of the stand and 2, the initial age of the stand.

Figure 2 shows that the average 15-year-old stand of loblolly pine has a density of stocking of 62 percent and the average 20-year-old stand has a density of stocking of 74.5 percent. It is reasonable to assume that a 15-year-old stand, 62 percent stocked at present, will in 5 years (at 20 years of age) be 74.5 percent stocked, an increase of 12.5 percent in stocking during the 5-year period. A similar assumption underlies the application of growth and yield tables.

From Figure 2 only the rate of density change

for average stocking can be computed. To facilitate obtaining rates of density change for any initial degree of stocking, graphic methods are employed. For each age class the stands are ranked according to degree of stocking and divided into equal groups, in this case *sextiles.* That group embracing the most poorly stocked stands is designated as the *first sextile.* Similarly, the group embracing one-sixth of the samples and representing the highest degree of stocking is termed *sixth sextile.* The average density of stocking for each sextile is plotted for each age class, loblolly pine in Figure 3, and Virginia pine in Figure 4. Freehand curves are fitted to the points as shown.

The use of sextiles permits the introduction of what may be considered a third variable; that is, density of stocking is used not only as the dependent but also as as independent variable. By this procedure the rates of change in degree of stocking for 5-year periods can be obtained for different initial densities and ages. For example, at an initial stand age of 15-years, the degree of stocking of loblolly pine (Fig. 3) for the first sextile is 17 percent; at 20 years the stocking is 30.5 percent, an increase of 13.5 percent in stocking during the 5-year period. This increase is plotted at 17 percent stocking (the stocking at the beginning of the period) in Figure 5.

Similarly, the change is computed for each of the remaining sextiles for the 15- to 20-year age period. The six points so obtained and plotted in Figure 5 form the basis for fitting a freehand curve which represents the change in density of stocking for 15-year-old stands. Considering, then, the period 20 to 25 years of age, the changes in stocking are computed for each sextile and curved in Figure 5. In a like manner curves are constructed for the remaining age classes. From Figure 4 changes in stocking for Virginia pine were computed and plotted in Figure 6.

Limitations

Site quality undoubtedly affects the rate of approach toward normal stocking, for it is reasonable to expect that for a given age and density index, a stand growing on a good site will increase in degree of stocking at a faster rate than will a similar stand growing on a poorer site. However, the data on hand are insufficient to measure site effects.

The method here presented for estimating change in stocking is limited by lack of sufficient data, particularly for very poorly stocked and overstocked stands. Although the theory upon which the method is based admits the possible occurrence of very poorly stocked stands of high ages, where cutting, fire, or other damage is not the primary cause of understocking, it implies that such occurrence is infrequent. The change in stocking for such stands cannot be estimated, primarily because of the lack of data, and also because it is doubtful whether such stands would follow trends similar to those shown. If a stand is so poorly stocked at the

Table 1.—Gehrhardt's formula applied to Loblolly Pine stands of different densities of stocking, for the 10-year period from 45 to 55 years of age, site index 80 feet[1]

d Density at beginning of period	y_1 Actual yield at beginning of period	dG Uncorrected growth during period	$g=dG\,(1.9\text{-}0.9d)$ Corrected growth during period	$y_2=y_1+g$ Corrected yield at end of period	$y_2 \div 5500$ Density at end of period	Change in density during period
Percent	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Percent*	*Percent*
10	480	70	127	607	11.0	+1.0
20	960	140	241	1,201	21.8	+1.8
30	1,440	210	342	1,782	32.4	+2.4
40	1,920	280	431	2,351	42.7	+2.7
50	2,400	350	508	2,908	52.9	+2.9
60	2,880	420	571	3,451	62.7	+2.7
70	3,360	490	622	3,982	72.4	+2.4
80	3,840	560	661	4,501	81.8	+1.8
90	4,320	630	687	5,007	91.0	+1.0
100	4,800	700	700	5,500	100.0	0.0

[1]Normal yield at 45 years of age = 4,800 cu. ft.
Normal yield at 55 years of age = 5,500 cu. ft.
Normal growth G during period = 700 cu. ft.

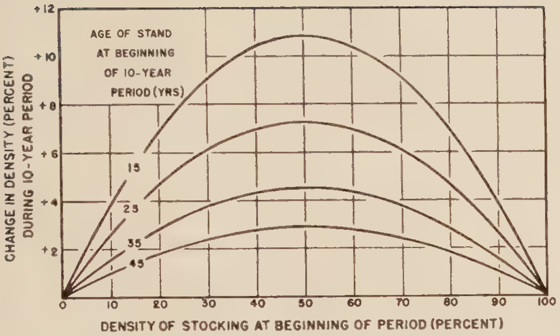

Fig. 1.—Changes in density of stocking as computed by Gehrhardt's formula for stands of loblolly pine of different densities and ages.

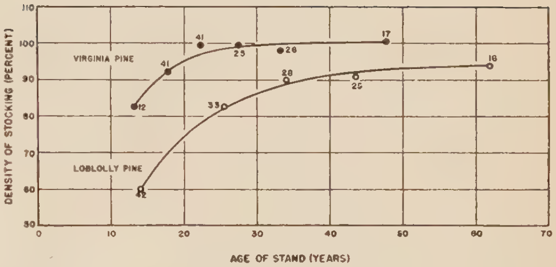

Fig. 2.—Average density of stocking of undisturbed, second-growth Virginia and loblolly pine.

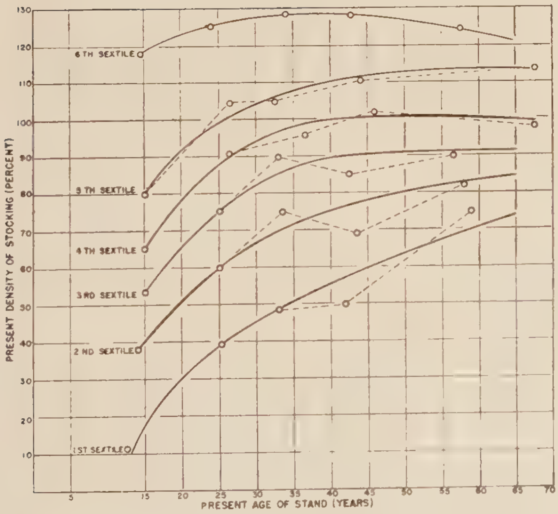

Fig. 3.—Trend of density of stocking for each *sextile* for even-aged stands of undisturbed, second-growth loblolly pine.

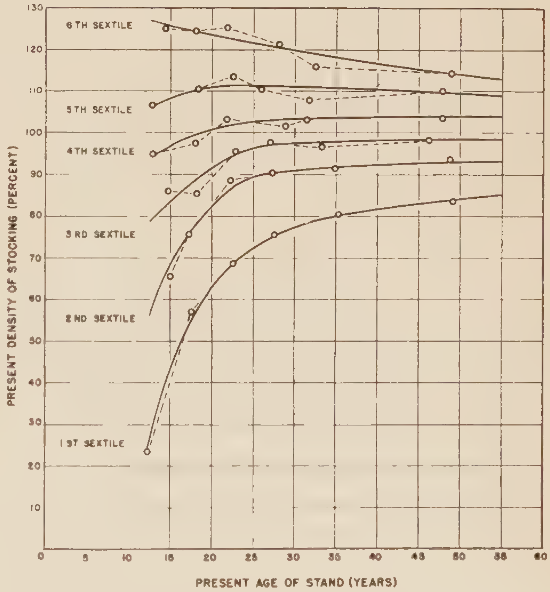

Fig. 4.—Trend of density of stocking for each *sextile* for even-aged stands of undisturbed, second-growth Virginia pine.

time of establishment that the individual trees exert no competition among themselves, then the growth of these trees is limited by the maximum growth capable for the species for its particular age and growing conditions. There would be no mortality due exclusively to competition (or stocking) and hence no resultant release and increase in growth. If the stand maintains its even-aged character, it will never completely utilize its site and reach normality.

Application

For the determination of the rate of approach of nonnormal stands toward normal stocking and the change in density of stocking, the final curves for loblolly pine (Fig. 5) were used for the example given in Table 2. The table shows the procedure for computing growth from normal yield tables by 1, the usual practice which does *not* account for change in stocking with age and 2, the proposed method of accounting for such changes. The following paragraphs describe in detail the procedure for obtaining the values in Table 2.

For the age of the stand (column 1) and the site index under consideration (80 feet) the normal yield is obtained from normal yield tables—for the beginning of the period (column 2) and at the end of the 5-year period (column 3). Columns 4 through 7 illustrate the procedure for computing growth when changes in stocking are *not* accounted for. By this method density of stocking is assumed to remain constant. If 50 percent (column 4) stocking at 15 years is chosen for purposes of illustration, the actual or reduced yield (column 5) at the beginning of each period is the normal yield (column 2) reduced by 50 percent. Similarly, the reduced yield at the end of the period (column 6) is the normal yield at the end of the period (column 3) reduced by 50 percent. The growth during the 5-year period (column 7) is the difference between the reduced yields at the beginning of the period and at the end of the period (column 5 subtracted from column 6).

To compute the periodic growth for a stand 50 percent stocked at 15 years when change in stocking is accounted for, the age at the beginning of the period (column 1) is used to obtain the change in stocking during the 5-year period (column 9) from Figure 5. This change during the period is added to the initial stocking to obtain the degree of stocking at the end of the period (column 8 plus column 9 equals column 10). The reduced yield at the beginning of the period (column 11) is obtained by multiplying the normal yield at the beginning of the period (column 2) by the degree of stocking at the beginning of the period (column 8). Similarly the reduced yield at the end of the period (column 12) equals column 3 multiplied by column 10. Thus the growth for the 5-year period (column 13) is the difference between the reduced yields at the beginning of the period and at the end of the period (column 11 subtracted from column 12).

The errors in the growth estimates resulting from failure to account for changes in stocking

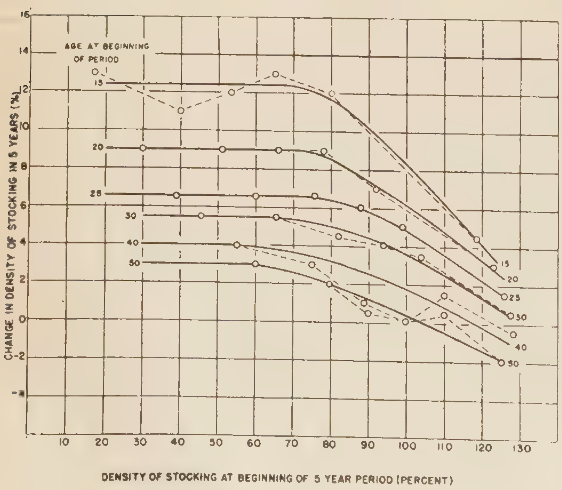

Fig. 5.—Change in density of stocking of loblolly pine for 5-year periods by age and density of stocking at the beginning of the period.

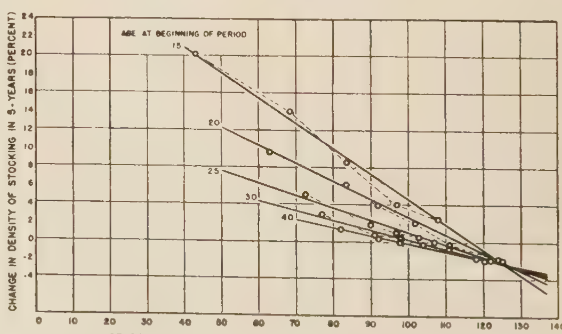

Fig. 6.—Change in density of stocking of Virginia pine for 5-year periods by age and density of stocking at the beginning of the period.

are shown in column 14 (growth in column 13 taken as a percentage of growth in column 7).

Summary

A method of estimating the rate of approach toward normality of abnormally stocked loblolly pine and Virginia pine stands is presented. It is indicated that the failure to account for such changes may lead to serious errors in growth predictions obtained through the use of yield tables.

The main advantage of the method is that the change in density with age is estimated from observed average differences in densities of present stands of different ages. Hence permanent sample plots or estimates of mortality are not required. This method is therefore presented, subject to possible future modification by a more precise expression of density of stocking and by a more adequate sample of stands of all ages, sites, and densities of stocking.

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TABLE 2.—A COMPARISON OF TWO METHODS OF COMPUTING GROWTH FROM NORMAL YIELD TABLES FOR SUCCESSIVE 5-YEAR PERIODS, USING AS AN EXAMPLE A STAND OF LOBLOLLY PINE 15 YEARS OF AGE, 50 PERCENT STOCKED AND SITE INDEX 80 FEET

	Not accounting for change in stocking						Accounting for change in stocking						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Age of stand at beginning of 5-year period	Normal yield[1] Beginning of period	Normal yield[1] End of period	Degree of stocking	Reduced yield Beginning of period	Reduced yield End of period	Growth for 5-year period	Degree of stocking Beginning of period	Degree of stocking Change during period	Degree of stocking End of period	Reduced yield Beginning of period	Reduced yield End of period	Growth for 5-year period	Error in growth estimate
Years	*Cu. ft.*	*Cu. ft.*	*Percent*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Percent*	*Percent*	*Percent*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Percent*
15	1,350	1,950	50	675	975	300	50.0	+12.5	62.5	675	1,219	544	81.3
20	1,950	2,600	50	975	1,300	325	62.5	+ 9.0	71.5	1,219	1,859	640	96.9
25	2,600	3,250	50	1,300	1,625	325	71.5	+ 6.5	78.0	1,859	2,535	676	108.0
30	3,250	3,850	50	1,625	1,925	300	78.0	+ 5.0	83.0	2,535	3,196	661	120.3
35	3,850	4,400	50	1,925	2,200	275	83.0	+ 4.0	87.0	3,196	3,828	632	129.8
40	4,400	4,800	50	2,200	2,400	200	87.0	+ 3.0	90.0	3,828	4,320	492	146.0
45	4,800	5,200	50	2,400	2,600	200	90.0	+ 2.0	92.0	4,320	4,784	464	132.0
50	5,200	5,500	50	2,600	2,750	150	92.0	+ 1.0	93.0	4,784	5,115	331	120.7

[1]Volume, yield, and stand tables for second-growth southern pines. U. S. Dept. Agric. Misc. Pub. 50, 202 pp., illus. 1929. (See Table 39.)

THE BLOCK-LINE METHOD OF PLANTATION EXAMINATION

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The steadily increasing task of plantation examination has created a demand for a more reliable and efficient method than the standard staking practice. Some officials have expressed doubts as to the accuracy of present estimates of plantation survival and have indicated the need of a method that will give a reliable mean together with its probable accuracy. The purpose of this paper is to describe a method which is practicable, usable for both survival and growth, and which at the same time meets ordinary statistical requirements. It has been tentatively designated the block-line method.

THE use of one or more rows of adjacent staked trees as a sample to be examined in estimating plantation success has been a standard policy with wide application in this country for many years. Generally, the location of these rows within the plantation is left to the judgment of the "staker" who is instructed to run them across topographic features so that various site conditions will be sampled. A favored procedure is to start at one corner of the plantation and stake a continuous row of trees across it in an approximately diagonal direction. Seldom more than 400 trees are staked in one plantation. The row ordinarily does not have a definite and predetermined direction but curves and zigzags at the discretion of the "staker." The unconscious entrance of personal bias is generally unavoidable under these circumstances. Moreover, representative sampling of the whole plantation seldom can be attained by the relatively short rows which result from the practice of staking adjacent trees and limiting the number of trees staked.

New Method of Examination

In the proposed block-line method the plantation[1] to be examined is divided into 2, 3, or 4 approximately equal parts or blocks with 2, 3, or 4 random sampling lines of milacre plots (6.6 by 6.6 feet) or staked trees, run across planted rows, examined in each block (Fig. 1). The plantation is divided into blocks on the basis of its size and minor site differences, or conditions that are expected to influence survival. Such apparent site differences or conditions should be roughly segregated into separate blocks, each block being as uniform as possible. For example, a plantation extending from creek bottom to ridge top should be divided about equally by the blocks into lower slope, middle slope, and upper slope, and two random lines, across planted rows, examined in each block. It is not necessary that block boundaries correspond exactly to the recognized minor changes in site within the plantation.

The following general instructions can ordinarily be applied in sampling plantations. In plantations under about 80 acres at least 6 random lines should be examined. If the plantation falls into 2 approximately equal parts on the basis of expected survival each part or block should have 3 random lines. If the plantation is apparently uniform and no minor site differences can be recognized it should arbitrarily be divided into 3 equal blocks and 2 random lines examined in each. Plantations larger than 80 acres should have 8 or 9 random lines examined. The same general procedure should be followed as above; the area designated as a plantation should be divided into 2 blocks with 4 random lines each, 3 blocks with 3 random lines each, or 4 blocks with 2 random lines each, depending upon the minor differences recognized.

This scheme of dividing the plantation into blocks and examining random sampling rows in each block has several distinct advantages:

1. Each part or natural division of the plantation is sampled, *i.e.*, representative sampling is obtained.

2. Bias due to the exercise of personal judgment is largely eliminated.

3. The error of estimate of the mean (standard error) is minimized, *i.e.*, the average is more accurate. This is accomplished by sampling separately in the several blocks. The block differences do not enter into the error of estimate.

4. Results can be calculated separately for each block. A better idea of the conditions of each

[1]From the standpoint of species makeup, time of planting, class and grade of stock, and general site classification, the plantation should be sufficiently homogeneous to satisfy the examiner that the results of the examination apply to one definable universe.

TABLE 1.—RESULTS OF PLANTATION EXAMINATIONS

Plantation	Area	Species and age since planting	Method of examination	Trees or milacres in analysis	Survival and standard error	Thrifty and standard error
	Acres			*Number*	*Percent*	*Percent*
1	15	Red pine	Standard staked row	204	99.5	88.7
		1-year	Block-line—2 random staked rows in each of 3 blocks	632	94.5 ±0.821	83.40±1.12
				149	94.63±2.43	83.89±3.48
2	56	Red pine	Standard staked row	400	96.5	77.3
		1-year	Block-line—2 random lines of milacre plots in each of 3 blocks	798	80.3 ±2.87	58.6 ±6.63
				264	81.6 ±5.66	61.75±6.52
				162	80.4 ±4.54	57.97±9.21
3	7.9	Long-leaf	Standard staked rows	201	22.89	14.43
		pine 1-year	Block-line—2 random staked rows in each of 3 blocks	308	25.97±0.555	14.29±1.75
				157	25.48±0.587	15.29±2.57
4	5.25	Long-leaf	Standard staked rows	207	57.97	47.34
		pine 1-year	Block-line—2 random staked rows in each of 4 blocks	169	44.38±3.75	21.89±2.21

major section of the plantation is thereby attained.

5. A reliable mean with a known degree of accuracy is obtained.

The block-line principle just described can be utilized in two ways. A random sampling line may consist of a line of milacre plots or a row of staked trees. The former is designated the milacre plot[2] and the latter the random staked row method. Actual tests of these variations of the general method together with the standard staking practice (standard staked rows) already described have been made and the results are shown in Table 1. In order to show the relation between the size of the sample and the reliability of the mean, the data were analyzed for different numbers of units. For example, Table 1 shows that, in plantation No. 2, 798 milacres distributed in 6 random lines, gave a percent survival of 80.3 ± 2.87. When the data were analyzed for each third milacre and each fifth milacre only, the results were 81.6 ± 5.66 and 80.4 ± 4.54 respectively. In this case the examination and tally of every fifth milacre was practically as good as a tally of every milacre plot in the 6 random lines. A similar procedure was followed in the analyses of data obtained from the random staked rows in plantations 1, 2, and 3.

[2]Cowlin, R. W. Sampling Douglas fir reproduction stands by the stocked-quadrat method. Jour. Forestry 30:437-439. 1932.

Haig, I. T. The stocked-quadrat method of sampling reproduction stands. Jour. Forestry 29:747-749. 1931.

Lowdermilk, W. C. A method for rapid surveys of vegetation. Jour. Forestry 25:181-185. 1927.

The results of the tests as given in Table 1 can be summarized as follows:

1. There is a conspicuous difference between the results from the standard staked rows and the random rows established by the block-line method. The limits established by the standard errors for the means of the random rows indicate that this difference hardly can be due to chance alone.

2. The results obtained by using different numbers of trees in the analyses show, in general, only very minor changes in the means and in their reliability.

3. In the 15-acre plantation 0.993 percent, in the 7.9-acre plantation 1.66 percent, and in the 5.25-acre plantation 2.68 percent of the total number of trees was a sufficient sample.

4. In the 56-acre plantation as few as 162 milacre plots in 6 random lines, or 0.289 percent of the 56,000 possible milacres, gave a satisfactory estimate of the percentage of survival and percentage of thrifty trees. It also gave a good estimate of total live and thrifty trees per acre, although these values are not given in Table 1.

Probably the major reasons for the bias exhibited by the standard staked rows was the presence of the personal element in choosing trees to be staked and non-representative sampling. In the block-line method the former was eliminated by the use of random sampling lines and by a predetermined and impersonal procedure in doing the work. Representative sampling was obtained by dividing the plantation into blocks and sampling within each block.

Suggested Field Procedure

A suggested procedure for the milacre plot method is given below. Establishment of random staked rows is done in much the same manner and the procedure given here can be followed with a few obvious changes.

1. On a sketch map of the plantation or planting project, divide the plantation into the requisite number of approximately equal sized blocks according to the principles already discussed.

2. From the map determine the number of paces along the block boundary most nearly parallel to planted rows. Place this many consecutive numbers in a box and blindly draw the re-

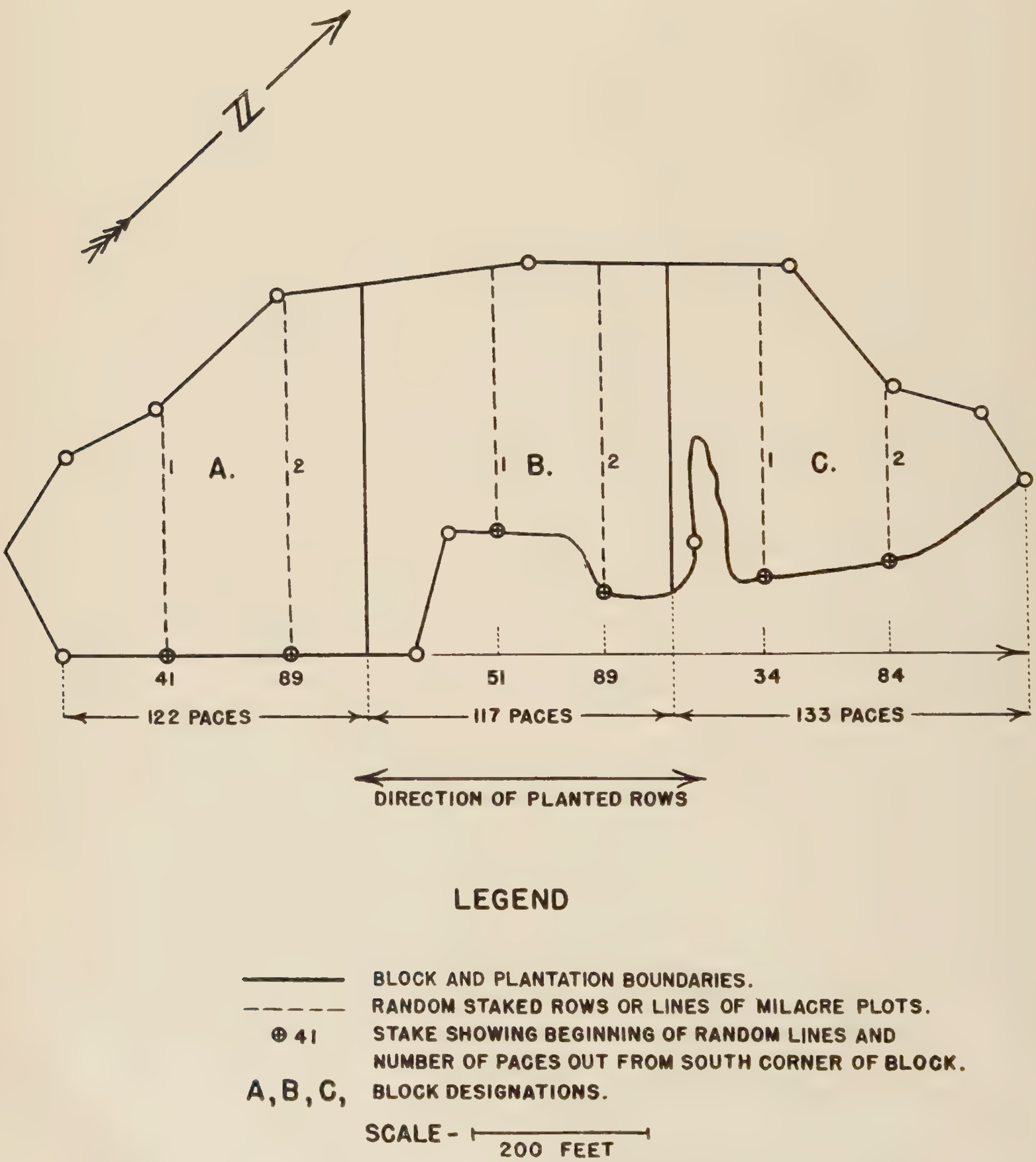

Fig. 1.—Illustration of the block-line method as applied to an actual plantation on an eastern national forest.

quired random numbers from this total. For irregular plantations this may be different for different blocks (Fig. 1). These numbers locate the random lines of milacres on the ground. For example, if a block is 100 paces from the southeast to the northeast corner and the numbers 26 and 82 are chosen at random, the beginning of the first random line of milacres would be 26 paces along the boundary from the southeast corner and the second 82 paces. Locate these random lines on the sketch map.

3. At the beginning of the random line pick out a landmark in the direction approximately perpendicular to the block boundary, mentioned above, or a base line (Fig. 1). A compass is often desirable although not necessary for this purpose.

4. With a light pole 6.6 feet long and another 3.3 feet long start the examination. If the average number of milacres in the random lines of the plantation is 39 or less, tally all milacres in each line; if from 40 to 59 inclusive, tally every other milacre; if from 60 to 79, every third milacre; if from 80 to 99, every fourth milacre; if from 100 to 119, every fifth milacre, etc. The average number of milacres in the random lines can be determined from the map. It is equal to the total number of milacres in the random lines divided by the number of random lines. The distance between tallied milacres can be measured with the 6.6-foot pole or by pacing, whichever is most convenient. It is not important that the tallied milacre or random line be accurately placed, but it is extremely important that they be placed in an impersonal manner.

5. The 6.6-foot pole is pointed in the direction of the landmark on the line of sight and laid on the ground or held in a horizontal position. Trees on either side of the pole can be checked with the 3.3-foot pole as to whether or not they fall within the milacre. This process is repeated along the random line with the landmark as a guide. The examiner should decide beforehand upon the details of his procedure and adhere closely to these rules. In this way personal bias can be eliminated.

6. Examinations in subsequent years should probably be done on the same random lines of milacre. It is impossible and unnecessary to tally exactly the same milacres but the same random numbers should be used.

Comparative Costs

Relative costs of estimating plantation values by staking methods can be based on the number of staked trees used. In plantations 1, 3, and 4 the number of trees sampled in the random staked rows was 73.0, 78.1, and 81.6 percent respectively of the number staked in the standard rows (Table 1). Some extra work is involved in setting the stakes in 6 or 8 random rows but after the routine is established this method should be no more, perhaps less, time consuming than the standard staking methods now in use.

The block-line method employing random lines of milacres offers even greater possibilities. Two men, examiner and tally man, examined the 56-acre plantation of red pine by this method in 3½ hours. This included the location of the random lines on the ground, from random numbers previously drawn, and their examination. Every milacre in the 6 random lines, or 798, was examined. Table 1 shows that 162 or each fifth milacre is sufficient. Trees were tallied as thrifty, unthrifty, and dead. Considerably more time could be saved by tallying simply as stocked and unstocked, or as thrifty, unthrifty, and unstocked. This would eliminate the careful examination necessary to make sure the milacre contains no dead tree. During the dormant season live conifers are very readily distinguished against the drab background of dead vegetation. By these means the time required to examine the plantation could be cut to 2 or 2½ hours.

The milacre plot method has several advantages over the use of random staked rows. It eliminates the expense and time needed to make, paint, and place stakes. It gives results directly in total live or thrifty trees per acre and a measure of the distribution of live trees over the area. On long random lines where it is necessary to tally only each fifth milacre or stake a tree in each fifth row crossed, the milacre plot method is to be preferred. Stakes spaced at this distance would be difficult to find. The chief objection to the milacre plot method is the possible difficulty of finding unstaked trees, particularly those of deciduous species, in certain types of vegetation. There are probably places where this difficulty is present but certainly this method is applicable in many places. It is recommended as a method deserving much wider use under existing conditions in eastern United States.

THE EUROPEAN SPRUCE SAWFLY IN NEW HAMPSHIRE 1938[1]

By HENRY I. BALDWIN

New Hampshire Forestry and Recreation Department

In northern New England spruce is more esteemed than any other tree by both foresters and landowners. It forms the basis of the pulp and paper industry, is in demand for lumber and piling; red spruce clothes steep mountain sides in the east and is the most important species in watershed protection and for scenery. Species of spruce are also extensively planted around reservoirs, for timber production and windbreaks. Spruce is a popular tree in forestry. Thus when any pest threatens to kill spruce, and has actually demonstrated its capacity to do so over large areas something ought to be done about it. The following report on the spruce sawfly attack in New Hampshire during 1938 and what was done about it will be of especial interest to foresters in the spruce region.

THE European spruce sawfly (*Diprion polytomum* Hartig) was first observed on Mt. Washington, N. H., in 1929. The following year attention of foresters was aroused by the serious depredations of the insect in eastern Canada. In 1931 larvae were collected in the Adirondacks, but not until 1935 was a general distribution of the sawfly in New Hampshire confirmed. During September of that year larvae were found by the writer in Randolph, N. H. A bulletin calling attention to the importance of this forest insect, and asking timberland owners to be on the lookout for it was issued by the New Hampshire Forestry and Recreation Department on September 16, 1935. The year 1936 passed with no reports of serious outbreaks, although representatives of the U. S. Bureau of Entomology and Plant Quarantine reported general light infestation as they had in 1935. In October a leaflet on the insect by Dr. H. J. MacAloney was published. The next year saw no change. Finally on August 29, 1937, L. W. Rathbun discovered an extremely dense concentration of sawfly larvae on the north side of Mt. Monadnock in the Town of Dublin. A few days later the writer observed a smaller area of similar intensity on the Peterboro-Temple line. Intensive scouting in that region revealed a moderate infestation in Stoddard and Washington. In 1938 the area of dense sawfly population had spread considerably around these two important centers, and moderate attacks have been found in 5 or 6 towns in the neighborhood. Light general infestation throughout the state was confirmed by a comprehensive survey of the entire state where spruce occurs.

[1]Presented at Conference on Spruce Sawfly, New England and New York Sections, Society of American Foresters, Crawfords Notch, N. H., September 1938.

Steps Taken for Investigation and Control

The damage caused by the nearly complete defoliation of spruce on Mt. Monadnock was at once apparent to all who saw it. Immediate spraying of small decorative trees was carried out by the landowners, and some attempts were made to prevent larvae climbing trees by banding the latter with tanglefoot. Appeals to the Bureau of Entomology and Plant Quarantine for aid and advice met with prompt response, and wholehearted cooperation from all members of the New Haven and Washington offices. Our entire program has depended on the efforts of this Bureau, and we have at all times endeavored to work with it and the state entomologist at the New Hampshire Agricultural Experiment Station as closely as possible.

Several problems immediately presented themselves. One was the salvage of the timber, much of which it was feared might die before the next season. The owners were assisted in the marketing and logging by L. W. Rathbun, forester for the Society for Protection of New Hampshire Forests. Through his efforts a large quantity of timber was cut without causing visible scars on the mountain.

Surveys of surrounding towns were instituted to determine if other severe infestations might exist. Collection of cocoons was accomplished with crews paid by the Society and by 4-H Club groups organized by the Cheshire County Farm Bureau. Several hundred leaflets were distributed among landowners in the vicinity. About 350,000 sound cocoons were obtained and taken to New Haven for parasite production at the laboratory of the Division of Forest Insects.

Investigations on the rate of mortality of defoliated trees and overwintering of the sawfly were started at once, and prosecuted until winter

weather prevented. On October 14, 1937, a conference of representatives of all the cooperating agencies was held in Durham, N. H., and the program for winter work outlined and duties allotted to each organization. The Society for Protection of New Hampshire Forests generously appropriated funds for the employment of a specialist who has devoted his entire time since March 1, 1938, to parasite breeding and introduction of the parasites in the field. The New Hampshire Forestry and Recreation Department instituted a cocoon population study and laid out some 100 permanent plots in the southern part of the state on state and private lands, and analyzed the duff samples collected on them. This was made possible by a W.P.A. professional project sponsored by the department. This report was completed on December 10, 1937. The New Hampshire Agricultural Experiment Station through the state entomologist made detailed studies of cocoons recovered in the above survey, and placed thermographs on Mt. Monadnock which were read throughout the winter in connection with a study of temperature tolerances of the insect.

Several plantings of the cocoon parasite *Microplectron fuscipennis* were made in the fall from the 1,300,000 received by the New Haven office through the courtesy of the Canadian government. Some of these were recovered in the spring, showing that they had become established.

Scouting Work During the 1938 Season

In April 1938 another conference of federal and state representatives was held in Keene, and plans were made for a more complete survey of the state. This resulted in one graduate entomologist supplied by the New Hampshire Agricultural Experiment Station and a volunteer worker under the New Hampshire Forestry and Recreation Department going into the field the second week in June in company with an experienced scout from the federal bureau. On July 12 another conference was held, and an additional federal entomologist added. These four men have now covered by an intensive survey all towns known to contain spruce, numbering 112. Whenever populations dense enough to justify parasite planting were met with, parasite units have been sent up promptly from the New Haven office and planted in the field. Reports have been sent in by the field men weekly and frequently more often. The progress of the survey has been marked on a map and each town blocked in as completed.

The White Mt. National Forest was not covered in this survey. However, the district rangers and timber survey leaders visited the infestation on Mt. Monadnock on August 2, 1938, and methods of scouting for sawfly were demonstrated by representatives of the U. S. Bureau of Entomology and Plant Quarantine. Not only have all forest officers been on the lookout for sawfly indications during their regular patrols and inspections but the leaders of a timber survey, covering 90,000 acres in the Waterville valley were instructed to scout intensively every stand of spruce. Detailed reports on the survey of the national forest have not yet been received.

The results of the scouting indicate that the only serious infestation in New Hampshire is in the southern highlands. The following is a summary of the scouting during 1938.

Lightly infested	101 towns
Moderately infested	9 towns
Heavily infested	2 towns
National forest lightly infested	24 towns
Total	136 towns

Parasite Liberation

The Office of Forest Insect Investigations in New Haven reared about 5 million *Microplectron* cocoon parasites. Of these about 1 million were sent to Maine, and the remainder were available for release in New Hampshire, Vermont, and New York. During the summer of 1938 there were released, at points in 26 different towns where there seemed probability of establishment, 38 colonies of approximately 930,000 parasites.

In 1937 there also were received from Canada 8,500 *Exenterus abruptorius* and 100 *E. adspersus* larval parasites which were liberated in New England. On July 8, 1938, about 6,000 of the first named species were liberated in Dublin and about an equal number in Temple. *E. oleaceus*, *E. tricolor*, and others have also been planted.

Outlook for Control by Parasites

Establishment of parasites has as its objective the resumption of the natural balance between the spruce sawfly and its natural enemies to which it is accustomed in its native habitat. Insect parasites should be colonized as rapidly as possible throughout infested spruce areas. The cocoon parasite *Microplectron* has been most fre-

quently mentioned since it can be propagated in enormous numbers in the laboratory and because it already has become established at a number of places in New England where it has been liberated. Obviously it cannot become established where sawflies are not sufficiently abundant. The minimum sawfly population density as measured most appropriately by cocoons which warrants colonization with *Microplectron* is unknown, but the Bureau of Entomology and Plant Quarantine does not recommend doing so where less than 2 sound cocoons per square foot can be found. The bureau also considers 2 or 3 colonies (30,000 parasites) per township of 36 square miles to be an adequate program. The basis for this contention is that if suitable environment for multiplication of parasites exists, they will increase at a much more rapid rate than they can be raised in the laboratory. If conditions are not suitable implanting millions of parasites will have no more immediate effect than a very few.

Microplectron is however, only one element in the whole parasite complex of the spruce sawfly. There are very many other species, and it is conceivable that some other species, even though liberated in comparatively small colonies may in a few years prove of greater importance than *Microplectron*. Parasites of other sawflies are also being tried. "Although we may hope that this species will help to control the sawfly we cannot logically expect a rapid build-up in percentages of parasitism. Experience with introduced parasites of other forest insects has shown that it may be several years before appreciable percentages of parasitism are obtained. The habits of the parasite indicate that it is much more likely to be important where the host cocoons are on or near the surface of the ground. Cocoons under deep layers of litter or moss are much less likely to be attacked by the parasite."

Spraying

A large number of landowners in southern New Hampshire have been spraying their shade trees as a protection against defoliation by spruce sawfly. At least two owners carried out more extensive spraying of forest stands using power sprayers and up to 2,000 ft. of hose. Trees so sprayed were protected but the expense is prohibitive on extensive areas.

Losses

It is estimated that approximately 5 million board feet of spruce has been so weakened by defoliation that its death is to be expected in 3 to 5 years. Even if the trees do not die as a result of the sawfly attack directly, their increment has been more or less permanently checked, and secondary enemies are liable to kill many of them.

Conclusion

The European spruce sawfly is so thoroughly established in the state that there is no hope of its eradication. We must therefore learn to live with it. Avoidance of excessive damage to spruce will depend upon an established natural balance brought about by equilibrium between the sawfly and the natural enemies, including insects, rodents, and birds.

New National Forests Bring Total to 161

THREE new national forests established since September 6, bring the total number in the United States to 161. Proclamations establishing the Mark Twain and Clark National Forests in the Missouri Ozarks and the Shawnee National Forest in southern Illinois have been signed by President Roosevelt and define the boundaries to include a gross total area of more than four million acres, of which 1,351,278 acres have been purchased under the Weeks Law or obtained from the public domain or under other authorizations.

REPORT ON FOREST PEST PROBLEMS IN NEW YORK

By H. L. McINTYRE
New York Department of Conservation

Some Sections of the Society of American Foresters are very active professionally. The New York Section for many years has been a good example of what all Sections of the Society might well attempt to be. Section committees or individuals have assumed or have been assigned the responsibility of studying certain technical problems and of reporting the results to the Section. The following report describes the pest problem in New York State. It also reviews in some detail the various control measures which have been found to be effective under New York conditions.

SEVERAL insects have become important forest pests in recent years. Some of these, notably the fir bark louse, the European spruce sawfly, the eastern spruce bark beetle, and the spittle bug, have received considerable study. The discussion which follows describes the areas known to be infested with insect pests, present methods of control, and conditions resulting from the outbreaks.

The fir bark louse (*Adelges piceae*, Ratz.).—The fir bark louse is mostly prevalent in the southern Adirondacks, especially in the towns of Arietta, Lake Pleasant, Indian Lake, and Wells, Hamilton County, and Minerva and Newcomb, Essex County. In view of the fact that the infestation is general and very heavy in this area, it seems probable that if a diligent search were made outbreaks north of the present known limits would be discovered. This thought is substantiated by the discovery of two outbreaks in October 1937; one in the Catskills, near Slide Mountain and the other in Berlin, Rensselaer County, both of which are long distances from the Adirondack outbreak. Until the past fall the latter outbreak was believed to be the limit of the fir bark louse in New York, but as the Catskill and Rensselaer County outbreaks were discovered without any particular search by an employee of the Conservation Department while on other work, the thought that the infestation is more widespread than present data indicate seems very probable.

Outbreaks of the fir bark louse are limited in so far as known to balsam fir. The insect attacks the trees in two ways:

(a) By sucking the sap, principally from the body of the tree.

(b) By causing swellings or cankers on the branches.

Heavy outbreaks are conspicuous. The body of a badly infested tree is frequently almost snow white because of the white, waxy substance with which the insect covers itself. This conspicuousness is dependent on the degree of infestation. Swellings or cankers are found mostly on reproduction and are not very conspicuous. However, a large number of cankers on badly infested trees are quite conspicuous and are usually fatal.

The European spruce sawfly (*Diprion polytonum*, Hartig.).—The European spruce sawfly is widely scattered. Surveys that have been made during the past two years suggest that it can be found anywhere in New York where spruce is prevalent. This sawfly may show a preference for red, black, and white spruce but very likely will thrive on any native or exotic species of spruce. Light outbreaks of this sawfly are obscure. The color of the larvae harmonizes closely with the host plant. Therefore, unless the outbreak is severe enough to cause some defoliation, a general infestation over extended areas may easily escape notice. The degree of infestation that may be expected on an area can be determined, to some extent, by examining the duff around the base of the trees during the fall; the abundance of pupae indicates approximately what may be expected the following season.

Although the European spruce sawfly has been known in New York since at least 1931, no commercial damage has yet been noted in the state. In the New England states it has caused considerable damage. The most severe outbreaks of this sawfly are in two widely separated areas: one in a Norway spruce plantation near Tupper Lake, the other in a white and Norway spruce plantation in Rensselaerville, Albany County. In both of these plantations heavy feeding was noted on a few trees.

Eastern spruce bark beetle (*Dendroctnus piceaperda*, Hopkins.).—The eastern spruce bark beetle very likely can be found anywhere in New

York where over-mature spruce stands exist. Severe outbreaks, scattered through the Adirondack and Catskill sections have occurred. The presence of the beetle is not easily detected, especially in the initial stage of the outbreak. Shortly after attack, however, the infested trees begin to shed their leaves. Consequently an abundance of green foliage on the ground may be an indication of an outbreak of this beetle. The presence of small round holes in the bark and small tubes of pitch are other means of determining outbreaks. The most conspicuous condition occurs mostly in well advanced stages through scaling of the bark by woodpeckers that dig out the grubs for food. After the woodpeckers have been at work for a while, badly infested trees turn a reddish-brown color and are noticeable for long distances. Damage as a result of spruce bark beetle outbreaks is quite extensive but limited to over-mature trees.

From plots that were established at Gid Lake, Trout Lake, and Morehouse Lake in southwestern Hamilton near the Herkimer County line, the following information was obtained. These plots had about 100 trees over 6 inches d.b.h. per acre but averaged 13-16 inches. The infestation ranged from 41 to 75 percent, and from 15 to 55 percent of the trees were killed. Infestation was confined mostly to trees over 8 inches; killed trees were almost entirely over 12 inches d.b.h. Somewhat similar data were obtained from one plot on Sentinel Range and another on Old Van Hovenberg Trail. The number of spruce above 6 inches d.b.h. was respectively 71 and 180 per acre. On both plots the d.b.h. averaged 13.2 inches and ranged from 6 to 23 inches. On the first plot, 17 percent of the trees were infested and 15 percent were killed; on the second plot, 15 percent were infested and 10 percent were killed. On both plots the infestation was confined almost wholly to trees above 10 inches d.b.h.

Spittle bug (*Aphrophora parrallela,* Say.).—The spittle bug has not been as widely publicized as some of the other forest insects. In so far as has been determined by outbreaks of importance, it is confined to the Hudson Valley Region. The only conspicuous stage in the life cycle of this insect is during the early summer when it is readily recognized by an abundance of spittle, sometimes to the extent that large numbers of trees may be entirely covered. Large areas of trees may be killed by the spittle bug, but except for the presence of spittle no outstanding symptoms are evident.

For the past three years, this pest has caused extensive damage to Scotch pine plantations. The most serious losses have occurred in the Middletown Watershed and Ashokan Reservoir, where practically all Scotch pines over 20 years have been killed. Fortunately the spittle bug is a cyclic insect and apparently reached its peak in 1936 or early in 1937. At any rate during July of 1938 the number of insects was suddenly and drastically reduced by a fungous parasite. The indications are that the normal cycle of this insect is about nine years, so that a recurrence of the trouble in epidemic form may be expected about 1944 or 1945.

Sawflies (*Tenthredinidae*).—The pine sawflies are better known than the insects previously discussed. Nevertheless, the yearly increase in the number of pine and larch sawfly outbreaks is a genuine cause for concern. Predictions about the future seem to be entirely out of order.

The two most outstanding features about saw fly outbreaks in New York are:

(1) They have been limited to plantations and the most severe outbreaks have been confined to red pine.

(2) Reports indicate that pine sawflies of one species or another are scattered over the entire state. Each outbreak is responsible for a certain amount of damage. In the aggregate, sawflies have caused considerable damage, particularly in the Black River region.

Control Measures

When the damage caused by a forest pest becomes alarming, the first question asked is: "What, if anything, can be done to control it?" In many cases the answer is that, inasmuch as nothing was done silviculturally to prevent these outbreaks from reaching the alarming stage, not much in the way of direct control now can be done.

Fir bark louse and eastern spruce beetle control.—In forests the only applicable control measures for the fir bark louse and eastern spruce beetle is to salvage the infested timber. In general, good forest management practices are an assurance against such outbreaks, as well as a cure for the trouble. During the time these outbreaks are building up, or even when they have reached a critical stage, the market value for the class of timber involved may not be high; never-

theless, the areas involved can be lumbered as cheaply during an infestation as at any time, and it is certain that the timber that has been recently killed or is dying, as well as timber that is subject to attack, is worth considerably more at that time than it will be a few years after having been killed.

The importance of the outbreaks of the fir bark louse and eastern spruce beetle in New York State has been somewhat over-emphasized. White pine weevil is causing more damage every year than the total damage resulting from these two insects, and until recent years the annual damage by white pine blister rust exceeded the total damage by both insects. Furthermore, in the gypsy moth infested area in New England more annual damage will be found than that caused by the beetle and louse outbreaks in New York.

Spittle bug control.—Three years of observation on the habits of the spittle bug in Scotch pine plantations have resulted in certain valuable, definite conclusions, which may be of assistance in combating the insect in future outbreaks.

(a) Damage is confined to plantations over 15 years of age.

(b) In larger plantations the insect population and hence the damage tend to be concentrated in the central part of the stand.

(c) No direct method of control has been devised which is practicable for a forest plantation.

(d) Silvicultural control through early thinning has been attempted, but results cannot be determined until another outbreak occurs.

(e) Other species of pine, though they become infested, are rarely injured, even when growing in the same plantation with severely attacked Scotch pine.

(f) Experience in New York with the spittle bug damage constitutes another good argument against extensive pure plantings of a single species.

Sawfly control.—Except for the spruce sawfly, the writer believes that spraying is a practical control procedure. Arsenate of lead has formerly been recommended, but fortunately a much more economical product recently has become available. This product is "Talc," manufactured by the Loomis Talc Company, Gouverneur, N. Y. It costs approximately $11 per ton. When properly used, "Talc" is effective. The procedure is to dust thoroughly the clusters of feeding larvae. As the pine and larch sawflies feed in large clusters, the "Talc" is easily applied where it will produce the best results without waste of material.

This or some other method of control for sawflies will very likely have to be used until the canopy already made in the red pine plantations is closed. It is primarily suggested to overcome the mistakes of the past. If future plantings are properly mixed, there will be little damage from sawflies.

White pine weevil control.—Opinions with regard to value of white pine weevil control vary greatly; however, it appears clear that where weevil control has been properly done it is effective. In weevil control work many more trees per acre have been treated than is actually necessary. However, dense planting is a partial weevil control procedure. Therefore, if mechanical control is practiced for a few years or until the canopy closes, the weevil problem after that will be of minor importance, or at least can be handled by management practices. This plan, like sawfly control, is suggested to help rectify past mistakes. If proper mixtures are used in future plantings, the necessity for weevil control will be greatly reduced.

In one of the reforested areas in New York a check of the weevil population in both plantations and in natural reproduction has been made for three years. This shows an average of 1.3 infestation per acre of plantation as compared with 5.6 infestations per acre of natural stands.

White pine blister rust control (*Cronartium ribicola*, Dietrich.).—The present program for blister rust control, which includes cooperation with the U. S. Bureau of Entomology and Plant Quarantine and the individual landowner, has been in operation since 1923. The cost for this work has run as high as $3 per acre. As a result of studies directed toward reducing the per acre cost and modifications in procedure, effective blister rust control practices have been developed.

White pine blister rust has caused heavy damage to pine in New York. However, the control campaign is now very effective and the amount of annual infection as compared with that of a few years ago has been greatly reduced. The greatest blister rust damage has occurred in young stands and in pine reproduction. Therefore, if a plantation or natural stand is protected until the canopy is well closed, possibly until it is 10 or 15 years

old, and if it is practically free from blister rust and ribes at that time, little commercial damage will result before the stand becomes merchantable. The density of ribes and the conditions for their reestablishment vary considerably in different stands. Consequently, certain stands have to be given attention more frequently than others. A feature of outstanding importance in connection with this control program, though not generally appreciated, should not be overlooked. This is the fact that white pine is reproducing in the eastern half of New York at the rate of one-half acre per square mile per year, or at least has reproduced at that rate for the past 20 years.

A review of past records show that from 1918 to December 1936, 1,748,612 acres were initially protected from blister and 389,866 acres were reworked, making a grand total of 2,138,478 acres covered, on which 51,107,334 wild and 111,394 cultivated ribes were destroyed. The cost was $1,719,172.89 or 80.4 cents per acre. This cost, when subdivided between the agencies that have been involved, is approximately as follows: state, 36.2 percent; individual landowners, 5.8 percent; counties, 0.3 percent; U. S. Bureau of Plant Industry 16.5 percent; U. S. Bureau of Entomology and Plant Quarantine, 0.2 percent; and emergency relief, such as E.C.W. and W.P.A., which was made available through the U. S. Bureau of Entomology and Plant Quarantine, 41 percent.

Another rather important feature in the blister rust program is in connection with the control campaign on reforested areas. All plantings have been initially protected. The first plantings have been reworked and in some cases have been covered three times. In all workings some 257,105 acres were covered on which 6,342,409 bushes were destroyed, at a cost of 99 cents per acre. The past cost of blister rust control per acre has been considerably higher, possibly more than three times, than it will be in the future.

Gypsy moth control (*Porthetria dispar* L.).—The gypsy moth campaign has been in continuous operation, in cooperation with the U. S. Bureau of Entomology and Plant Quarantine, since 1933. The purpose of the campaign, through the so-called barrier zone program, is to prevent the further westward spread of the gypsy moth. The campaign has been extremely successful. In spite of the fact that for many years previous to the initiation of this project the gypsy moth spread westward at the rate of six or more miles per year, the spread has been absolutely halted in the 15 years the campaign has been in progress. During the duration of this program, gypsy moth outbreaks have been found and treated in every county bordering the New England states, from Essex to the Bronx, inclusive. Additional infestations have been found and treated in Queens, Nassau, and Suffolk Counties on Long Island and west of the Hudson River in Ulster and Albany Counties. The outbreaks found to January 30, 1937, aggregate 379 with 139,213 egg clusters. The writer believes that except for the gypsy moth control program this insect would have spread at least to Lake Erie and very likely still further west.

Since the start of the gypsy moth program a special effort has been made to keep the field personnel of the New York Conservation Department acquainted with gypsy moth and other pest problems. The field personnel has been requested to make special and frequent observations and to report unusual disturbances in the forest canopy. In addition to this, three complete surveys of the state have been made; the last one in the fall of 1936 and spring of 1937. These surveys were directed towards finding the places where the moth could be introduced by the traveling public and public carriers. Public parks, landscape developments, tourists' homes and communities, hotels, campsites, and railroad terminals were inspected for the presence of gypsy moth. It is believed that these inspections furnish very accurate information with regard to the gypsy moth situation in New York State.

During the past three years, three of the most important colonies ever found in the state were discovered. These findings emphasize the need for intermittent inspections of the entire barrier zone and immediately adjacent sections. They do not reflect on the effectiveness of the program. In so far as damage by the gypsy moth is concerned, none has occurred.

The cost of keeping the gypsy moth from becoming permanently established in New York, when compared with the success of the campaign, has not been unduly high. State appropriations to June 30, 1937, aggregate $1,878,280; contributions by the federal government through the Bureau of Entomology and later the Bureau of Entomology and Plant Quarantine aggregate $1,111,086. If this amount is charged to protection of the 400,000 acres in the barrier zone, the cost is approximately $7.473 per acre for fif-

teen years or $0.498 per acre per year. On the other hand, if we distribute the cost, as it properly should be, to the 12,000,000 acres of forest land in New York, the cost is .249 cents per acre for 15 years or .016 cents per acre per year. Regardless of how the cost is distributed, it is an absolute certainty that if the gypsy moth should become permanently established in New York, much more money would be spent annually to keep even parks and recreational areas habitable than is now being spent to protect the entire state.

European pine-shoot moth control (*Rhyacionia buoliana* Schiff.).—Not much has been heard in the last few years about the European pine-shoot moth. It is very likely, however, that those who believe the shoot-moth was completely wiped out by the cold weather in the winter of 1934 have a disappointment in store for them. At present the shoot-moth is building up very rapidly. It is not difficult to find outbreaks now where the infestation is just as heavy, possibly a little more so, than it was in 1934. In October 1937 an outbreak was discovered in the environs of the Saratoga nursery. It was introduced there in connection with the landscaping work on the Saratoga Reservation. Some 300 trees were destroyed. Fortunately this outbreak was discovered before it spread to the nursery stock through which it might have been introduced into reforestation areas.

The European pine-shoot moth can be destroyed by removing and destroying the infested buds or by spraying. Because of the cost, both methods are usually restricted to ornamental plantings. If the shoot moth is kept out of the young forest stands until they are 15 to 25 years of age, depending entirely upon the vigor of the stand, no further treatment will be necessary.

Different types of control of the shoot moth have been attempted in other states. However, it is believed that if zones free of shoot moth are maintained around the young stands until they reach the resistant age, the control of shoot moth will not be difficult. Zones two miles wide have been established around the state nurseries, all of the state reforested areas, and some county plantings in the southern part of the state. A brief analysis of the zone work discloses the following: 2,151 square miles having 44,765 acres of forest planting were covered at a cost of 81¼ cents per square mile, or .03 cent per planted acre. The maps and other records prepared in connection with this work will reduce the cost of the next inspection by a considerable margin.

Conclusions

(1) The gypsy moth, because it feeds on most all of our native trees regardless of density or age, is still a most serious forest pest in New York.

(2) White pine blister rust or white pine weevil, it is exceedingly difficult to determine which, is a close second.

(3) Age and density of the stand are very important in relationship to insect resistance or susceptibility. Some insects are more serious in dense stands, while others are more serious in open stands. A knowledge of the insect problems of the state is necessary to plan intelligent planting or cultural operations.

NEEDLE DROOP OF PINE

By W. C. DAVIS, GEORGE Y. YOUNG, and LESLIE W. ORR

Bureau of Plant Industry in Cooperation with Civilian Conservation Corps, and Bureau of Entomology and Plant Quarantine

Needle droop of pine has caused considerable apprehension among foresters in the Lake States. On the whole, red pine has been unusually free of highly destructive insects and fungi. When needle droop was first observed several years ago, it appeared as if the future of this fine forest tree might be clouded. It is reassuring, therefore, to find that at the present at least needle droop should not be the cause of great alarm because it appears to be the result of unfavorable factors, such as drought, heat, or frost.

An abnormal drooping of the needles of the current year's growth of red pine (*Pinus resinosa* Ait.) resulting in the premature loss of most of the affected needles, appeared late in the summer and in the fall of 1935 in certain localities in Minnesota, Wisconsin, and Michigan. The name *needle droop* has been used in describing this condition.[1] The symptoms observed in these Lake States, as well as in certain other sections of the country where somewhat similar conditions developed in 1936 and 1937, were so distinctive that it is believed worthwhile to publish an account of the observations made thus far.

Occurrence of Needle Droop in 1935

The needle droop as observed in Minnesota, Wisconsin, and Michigan was limited almost entirely to red pine, although an occasional northern white pine (*Pinus strobus* L.) showed what appeared to be the same type of injury. First observations of the occurrence of this disease condition were made early in August 1935, on red pine in northern Wisconsin and Minnesota. Subsequent examinations indicated that the droop was associated with slight to severe injury to the affected trees. Although many of the affected shoots and in some cases entire trees died, many trees which showed needle droop in 1935 produced an apparently normal shoot growth in 1936 (Fig. 1, *B* and *C*). The droop was most common on plantation stock ranging up to about 20 feet in height. Natural reproduction and nursery stock were seldom affected.

When the drooping was first observed in 1935 the needles were green and appeared normal except for their unusual position. The point of bending as shown in Figure 1, *C* was about one-fourth of an inch from the base of the needles in the actively growing region, which is enclosed by the sheath; all the needles within any one fascicle were affected. There was no evidence of external injury. A browning of some of the affected needles of the current year's growth took place later in the fall of 1935, starting from the point of bending and progressing outward toward the tips. Those needles which were bent over at a sharp angle had a conspicuous constriction at the point where bending had occurred, and died and dropped off later that fall or during the following spring. In cases of less severe bending, some of the drooped needles remained alive and green through 1936, although they did not resume their normal upright position. Such needles usually showed lesions characterized by resin deposits at the point of bending. In most cases the needles that remained alive were those on the basal part of the 1935 growth; those on the distal part of these same shoots died and dropped off.

The early part of the 1935 season was unusually favorable for rapid growth of vegetation. At Cass Lake, Minn., more than 8 inches of rain fell during the period from June 1 to July 11, which is considerably above normal for this locality. As a result, the needles of young red pine trees were longer by mid-summer than they would ordinarily have been by the end of the season. This unusual length and succulence of the needles may have had some connection with the occurrence of the needle droop, but positive evidence is lacking. The relative rate of 1935 needle growth in Wisconsin and Michigan is not known. In contrast to the unusually heavy rainfall in the months of June and early part of July, above average temperatures and below average rainfall occurred late in July and early in August.

Drooping and browning of some of the needles on the current year's growth were the only apparent injuries to the droop-affected trees in the

[1] Davis, W. C., D. H. Latham, and Geo. Y. Young. Some disease developments in forest nurseries. Phytopath. 27:127. 1937.

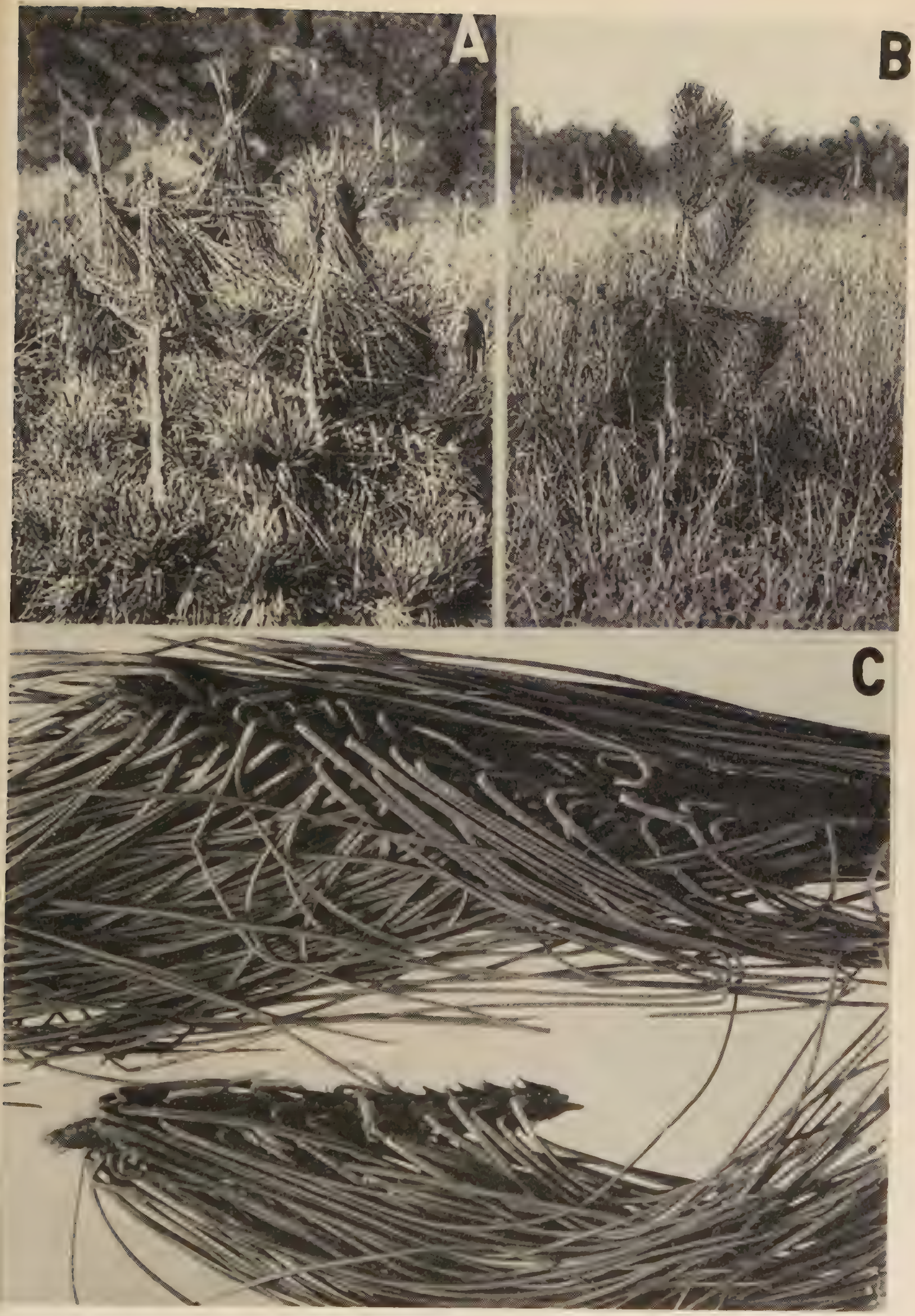

Fig. 1.—*A*. Needle droop that was associated with death of young red pines in a plantation in 1935. *B*. Apparent healthy 1936 growth of a red pine that was affected by needle droop in 1935. *C*. Typical red pine needle droop showing acute angle bend of all needles within any one fascicle. Note that droop appeared on needles of current year only.

fall of 1935; the twigs and all other parts appeared to be normal. In the spring of 1936, however, it was found that some of the 1935 twigs were dead, and others showed various degrees of injury. The tissues of the dead twigs and of their terminal buds were characterized by a dry, fibrous, somewhat shriveled condition with no indication of decay or insect attack. In some cases the twigs remained alive but the terminal buds were dead. These dead buds were often replaced by lateral or adventitious buds which developed and formed tufts of needles at the ends of such branches.

The degree of injury resulting from the needle droop seemed to be inversely correlated with the age or size of the trees. In affected stock sufficiently large to have developed a number of lateral branches, death of the entire plant did not occur unless at least two-thirds of the twigs were affected. Small trees having not more than two or three whorls of lateral branches usually died (Fig. 1, *A*). Within a given area the prevalence of needle droop showed no marked correlation with exposure to climatic conditions.

On the Chippewa National Forest near Cass Lake, Minn., about 80 percent of the red pine trees were injured in a plantation area of at least 200 acres. Trees of all sizes up to about 20 feet in height were affected, but trees less than 6 feet tall were injured most severely. A few of the smaller trees died. On the Red Lake Indian Reservation, in a small and somewhat younger plantation, it was found that 50 to 60 percent of the trees were affected, and that about 40 percent of the affected trees died. Needle droop was also noted on a few trees in several other isolated localities in northeastern Minnesota.

The most severe injury observed in Wisconsin was in three plantation areas near Trout Lake. The first of these, a 3-or 4-year-old plantation, was almost completely destroyed; in the second, an 8-year-old plantation, the injury was severe but the actual mortality was relatively light; and in the third area, a plantation about 20 years old, many trees were affected, particularly on low ground where the trees were smaller in size, but there was very little mortality. In two young plantations near Three Lakes, the injury was relatively light and little mortality occurred. Similar observations have been made near Phelps.[2] It is not known whether the death, in 1936, of some of the trees which showed droop symptoms in 1935 was caused by needle droop or the 1936 drought.

The only definite droop injury observed in Michigan was in a nursery near Sault Sainte Marie, where 3-year-old red pine transplants were affected. Droop injury was not observed in Michigan plantations.

Occurrence Subsequent to 1935

No recurrence of the typical 1935 needle droop in plantations or natural stands has been observed in the three Lake States, despite the unprecedented heat and drought of 1936.

In nurseries at Trout Lake and Wisconsin Rapids, Wisconsin, however, needle droop of 2- and 3-year-old red pine seedlings was observed in July 1936. Most of the drooped seedlings were found along the margins of drought-killed patches. Experimental variations in watering at one of the nurseries failed to produce droop symptoms.

Carl Hartley of the Division of Forest Pathology searched for needle droop in red-pine plantations in the northeastern states in the late summer of 1936. He reported that no droop was found although on the southern boundary of New York State basal lesions were noted on erect green needles.

In 1937 typical droop of red pine occurred in a Massachusetts forest plantation. Specimens of needle droop were also received from several foresters of northwestern states. It was reported that the droop was most serious on ponderosa pine (*Pinus ponderosa* Lawson) up to about 12 feet in height. The opinion of several of these foresters that the droop on ponderosa pine was caused chiefly by frost was supported by studies of climatological data.

At a nursery in Maryland severe injury by drought suddenly became apparent on July 9 and 10, 1936, among 3-year-old red pine and 2-year-old northern white pine in a number of broadcast-seeded beds. Such injury was most pronounced along a strip of varying width running lengthwise through the middle of each bed. No evidence of needle droop was observed about July 14 when shade frames were placed over portions of several of the drought-affected beds. However, by July 25 many of the trees bordering the drought-injured strips showed droop symptoms similar in appearance to those observed in Minnesota, Wisconsin, and Michigan in 1935. Such droop-affected trees were limited almost entirely to the unshaded portions of the beds. Al-

[2]Lorenz, R. C., and C. M. Christensen. U. S. Dept. Agric., Bur. Pl. Indus., 63 pp. (Mimeographed). 1937.

though shading of the beds following the drought period seemed to have little effect upon the general recovery or survival of the stock, such shading did appear to have a marked effect upon the occurrence of the droop symptoms. To determine whether there would be any tree mortality associated with the droop, 63 red pine trees showing various degrees of droop were marked on August 6. The results, as recorded October 20, showed 100 percent survival of these trees although there was some loss of needles and terminal buds.

Freezing or near-freezing temperatures also occurred at the Maryland nursery about November 10, 1936. A few days later, lesions just above the sheaths were observed on the needles of nearly all of the 2-year cluster pine (*Pinus pinaster* Ait.) and some of the 1-year loblolly pine (*Pinus taeda* L.). It is believed that these lesions were the result of frost injury. Affected stock was limited to the lower parts of the nursery.

Droop symptoms, which somewhat resembled those observed in the three Lake States, were produced on red pine in a preliminary greenhouse experiment. Fourteen 3-year-old potted seedlings held at 90°-100° F. were given no water for a period of approximately 20 days. About three weeks after normal watering was resumed 5 of these seedlings developed droop symptoms. Ten control trees that received normal watering at all times developed no symptoms of droop. Several other attempts to produce droop symptoms by controlled temperature and moisture conditions were unsuccessful.

Suggested Causes of Needle Droop

No fully satisfactory explanation of the cause of the needle droop observed in the three Lake States in 1935 is yet available. There is no evidence that either insects or microorganisms were responsible. Frost injury has been suggested, but it is not considered to be a sufficient explanation because droop occurred in areas where there was no frost for at least a month prior to the time when the droop appeared. It seems more likely that the droop may have resulted from some abnormal physiological condition, perhaps associated with the unusually rapid growth which occurred during the early part of the season. The temporary drought conditions following a period of rapid growth may have injured the trees in such a manner as to result in the droop symptoms. The experimental work which has been done in an attempt to produce the droop symptoms by controlling the moisture supplied to trees has not given definite results, but should be repeated under conditions more nearly comparable to those which existed in Minnesota and Wisconsin in 1935 and on trees which are just completing a period of vigorous needle elongation.

It seems reasonable to suppose that the young tissue in the basal portion of a pine needle during the period of rapid growth would be more easily injured, by any one of a number of unfavorable factors such as drought, heat, or frost, than would the older parts of the needle. Frost appears to have been responsible for the injury in certain cases, such as in Maryland and in the Northwest. Further observations and study may show that needle droop can be caused by various factors or combinations of factors. It is not believed that the condition is one which will often be of much economic importance.

DIRECT SEEDING—A REVIVAL[1]

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Since the large scale failure of direct seeding in the early days of forestry in the United States, artificial reforestation has been considered almost entirely in terms of planting. In this article the author protests the abandonment of direct seeding while still in its infancy and presents the results of experiments conducted to determine the factors affecting success and failure in direct seeding.

THE vast acreage of logged-over and burned-over forest land in the United States has created a reforestation problem which has thus far baffled foresters for an adequate solution. At the present time, planting of nursery grown seedlings and transplants is the accepted method of reforestation. Planting, however, is an expensive and slow operation. At the present rate and cost of planting, it will require approximately one hundred and thirty years and an expenditure of one and one-half billion dollars to reforest the ninety-one million acres of now denuded forest land which is not reproducing naturally.

In addition to the financial drawbacks and the time element involved, the accepted methods of planting are far from ideal from a silvicultural standpoint. Stands regenerated by planting lack the deep normally distributed root systems of natural stands. Since the spacing used is generally wide, natural selection and pruning do not play in full their vital roles in producing a healthy, vigorous forest with clean, straight boles.

It is apparent that if the problem of reforesting this vast acreage of denuded land is to be solved, cheaper and silviculturally more desirable methods must be developed. Three possibilities are suggested: the field planting of seedlings contained in soil briquettes—a method which is too costly for practical use (*4*); the field planting of germinated seeds contained in pellets or fertilizer cartridges—a technique which as yet is undeveloped (*3*); and direct seeding. Direct seeding, when successful, not only is cheaper than planting but in addition possesses the silvicultural advantages of natural reproduction.

During the early part of this century the method was extensively tried and, because of almost universal failure, was discarded. In the Northern Rocky Mountain Region, Wahlenberg (*5*) reports the success from fifteen thousand acres of these early seedings as only six percent, with the liberal connotation of one hundred or more seedlings per acre on the word "success." At the time of these early direct seeding activities, however, little information of a scientific nature on the factors of success and failure was available. In the light of our present knowledge of seed germination, rodent behavior, mycorrhizal associations, and other factors of germination and survival, we may understand the reason for the failure of many of these early direct seeding efforts, and marvel at the few outstanding successes which did occur.

At the present time there seems to be no solution to our reforestation problems other than planting and direct seeding. Since direct seeding, when successful, is both economically and silviculturally superior to planting, it would seem only logical that further research be devoted to this method. From our vantage point of backsight on the early attempts at direct seeding, and in the light of our present knowledge of the factors of success and failure, it is highly possible that a practical method of reforestation by direct seeding may be developed.

Experimental

With this reasoning as a background, a series of direct seeding experiments[3] were conducted at the University of Idaho's experimental forest during the years of 1936-1937, and 1938 with western white pine (*Pinus monticola*) and ponderosa pine (*P. ponderosa*).

Four areas were selected for the study. Three of the areas were steep north slopes for the western white pine, and one was a gentle southwest slope for the ponderosa pine. Previous efforts

[1]This paper is a progress report on direct seeding studies in the Northern Rocky Mountain Region initiated at the School of Forestry, University of Idaho, and carried out by the writer under the guidance of Drs. E. R. Martell and A. B. Hatch.

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[3]Tinsley, S. L. Direct seeding in the Northern Rocky Mountains. Jour. Forestry 36:1158-1160. 1938.

to reforest these areas by planting had resulted in failure.

All seeding was done by the seed-spot method with variations of mulching, shading, protecting, from rodents, forcing with "Hotkaps,"[4] and pretreatment of the seeds to hasten germination.[5] The basic method consisted of scalping off an area of 16 to 18 inches square, working up the soil to a depth of two to three inches, dropping the seed in the center of the spot, and covering with a quarter of an inch of soil.

Except for the fall-seeded western white pine which received only five seeds per spot, 20 seeds of western white pine or 14 seeds of ponderosa pine were sown on each spot. The number of seeds was chosen on the basis of the germinative energy of the seed; the object being to have 10 seeds which would germinate on each spot. The spots were spaced approximately six feet by six feet according to general field planting practice, although where necessary the spots were moved as much as two feet in order to take advantage of the shade offered by down logs and stumps.

Four hundred seed spots of each method of seeding were used. These were divided into plots of 20-seed spots each. The plots were laid out on the areas by a modification of Fisher's (*2*) method of random sampling which was almost identical to that later described by Wakeley and Chapman (*6*).

All plots were examined in May 1937, and those which had not been a total failure were reexamined in October of the same year. On one of the western white pine areas, observations were made during the second growing season. The results are given in Table 1.

Method three, which consisted of covering the spots with "Hotkaps," yielded the best results with ponderosa pine, but even this method with only 19 percent first-year establishment cannot be termed as successful. All other methods resulted in failure with this species because of the high population of Columbian ground squirrels (*Citellus columbianus*) which consumed practically all seed sown and found little difficulty in digging out the screen protectors on this area. For some unexplainable reason, these rodents did not attack the seed spots which were covered with "Hotkaps" until after they were opened. After opening, however, they either consumed the entire young seedlings or badly damaged them by biting off the ends of the cotyledons while attempting to get the seed coat with its remnant of endosperm. Aside from the protection offered against ground squirrels, the "Hotkaps" offered further advantage in forcing the seedlings early in the season. This developed larger plants which were better able to cope with the drought and insolating temperatures of mid-summer.

With western white pine, methods two, five, and eight which were protected from rodents with screen protectors far surpassed other methods, both in the percentage of successful spots and the number of seedlings per spot. Method eight, which was fall-planted and protected, would have probably exceeded methods two and five throughout had it not been for the fact that only five seeds were sown per spot in this method as contrasted to 20 seeds per spot in all other methods as previously explained.

That seed which has been pre-treated to hasten germination is necessary for spring sowing, is shown by the absolute failure of method six which, although partially protected from rodents, was sown with non-stratified seed. The effect of location in relation to success is very apparent. With every method, locations 1 and 3 gave vastly superior results to location 2. This, no doubt, is because location 2 is situated farther from the edge of the forest and carries a higher population of Columbian ground squirrels. Although Columbian ground squirrels occurred occasionally on locations 1 and 3, the bulk of the rodent population on these areas consisted of field mice (*Microtus montanus*) and chipmunks (Eutamius Sp.). Field mice and chipmunks are apparently able to do as much damage as the ground squirrels to unprotected spots, but are not large enough to disturb the screen protectors. It is interesting to note that although the Columbian ground squirrels are apparently "afraid" of the "Hotkaps," their much smaller relatives find little difficulty in tearing small holes in them and enjoying their feast in the privacy of a waxed paper cafeteria.

At the time of the fall examination, the screen protectors were removed from half of the western white pine spots. Observations made the following summer showed a slight loss from heaving on these spots, while on those spots on which the

[4]"Hotkaps" are commercial plant-forcers manufactured for the horticultural trade by Germains' Inc. of Los Angeles.

[5]Preliminary experiments with methods of hastening the germination of the species used indicated stratification at 5° C. for eight weeks was the most desirable method. The results were essentially in agreement with those of Barton (*1*).

Table 1.—Success with Direct Seeding of Ponderosa and Western White Pine

Method	Treatment	Percentage success: Ponderosa pine	Western white pine: Location 1	Western white pine: Location 2	Western white pine: Location 3
1	Not protected stratified seed	3.5	2.0	0.8	0.0
2	Protected stratified seed	7.5	72.5	18.2	52.5
3	"Hotkaps" stratified seed	18.7	5.5	5.8	3.7
4	Mulched stratified seed	11.7	2.0	0.8	2.5
5	Protected mulched stratified seed	5.5	76.5	29.9	82.5
6	Seed not stratified. Alternate rows protected	0.3	0.0	0.0	0.0
7	Fall seeded not protected				5.5
8	Fall seeded protected				76.3

screens had not been removed, the seedlings had become so large that the protectors were interfering with normal development. From these observations, it would seem that the protectors should be removed at the beginning of the second growing season, but after all danger of frost has passed.

Application

The results of these experiments apparently indicate that the success of direct seeding is influenced significantly by two of the several factors investigated, namely, (1) by stratification of spring sown seeds, and (2) by protection of seed spots from rodent depredations. The data on these two factors are so clear-cut that one is led to wonder how any success could have resulted from the early direct seedings in which these factors were ignored. The study does not provide a practical solution to the direct seeding problem in the Northern Rocky Mountains. It does, however, demonstrate that additional experimentation is justified before we abandon completely the direct seeding idea in favor of the doubtful economic procedure of spending large sums on the raising and planting of small trees.

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Canada's Forests

CANADA'S forests occupy about 783 million acres, or more than one-third the total land area of the Dominion, according to the Department of Mines and Resources, Ottawa. More than half of the forest area—492 million acres—is capable of producing timber of commercial value. Of the productive forests it is estimated that 230 million acres at present carry timber of merchantable size, and on 262 million acres there is young growth of various ages to meet future demands.

The total amount of timber of merchantable size in Canada's forests is estimated at 273,656 million cubic feet, of which 170,144 million cubic feet is considered accessible by means of the present transportation facilities. This accessible and merchantable timber includes 245,313 million feet board measure of wood suitable for the manufacture of sawn lumber and 1,107 million cords which may be utilized as pulpwood, fuelwood, and mining timber. The softwoods, which are in the greatest demand for construction and for the manufacture of pulp and paper, comprise about 80 percent of the total stand and about the same proportion of the annual cut.

EUROPEAN LARCH REPRODUCES IN EASTERN NEW YORK

By DAVID B. COOK

Civilian Conservation Corps

European larch planted in the Northeast produces cones but only rarely does natural regeneration appear and then sparingly. There is reported here a situation where larches imported from England in 1867 have produced abundant and aggressive reproduction. Some of the first American generation are exceptionally fine trees.

THE native range of European larch (*Larix decidua* M.) is limited to a small area of mountainous country in central Europe,[1] but, by forest planting, the species has been spread throughout most of central and western Europe and the British Isles and into areas far below its normal altitudinal range. Within its natural range it often forms pure stands but, through over-exploitation, it is partly being replaced by other kinds of trees.[2] Elsewhere, natural reproduction is spotty, so that planting is commonly resorted to for the production of new stands. In the northeastern United States it has been planted since Colonial times but was not used to form forest stands until after 1860. Records of reproduction from such stands are rare. Hunt[3] reports only one case. The writer has heard of three more and is acquainted with a fourth, reported herein, which is the *only known case* where planted European larch is reproducing abundantly.

In 1866 Hiram Cranston built a mansion on the outskirts of the village of Stephentown in Rensselaer County, N. Y. In keeping with the English tradition the grounds were landscaped. Today, the most conspicuous feature of the planting is a row of larches along the road and groups about the house. The mansion is situated on the moderate southeast slope of a glacial kame, against the southeast corner of the Rensselaer Grit Plateau. The soil is Gloucester stony loam,[4] a coarse, stony soil derived chiefly from the grit. On this particular site the soil inclines to dryness, due to a porous subsoil and nearness to the brow of the kame. The elevation is 1,000 feet. Two stations, both across the line in Massachusetts, supply weather data. Pittsfield, elevation 1,037 feet, is 10 miles southeast; Williamstown, elevation 711 feet, is 14 miles northeast. Weather data from stations in Rensselaer County are not comparable, due to differences in topographic position and in elevation.

TABLE 1.—WEATHER DATA

	Pittsfield Mass.	Williamstown Mass.
Mean temperature	46.0° F.	45.5° F.
Av. temp. June 1-Sept. 30	65.7° F.	64.6° F.
Mean annual precipitation	40.98 inches	38.34 inches
Mean annual snow fall	58.9 inches	59.3 inches

The larches planted by Cranston number 56, of which 43 stand in single line along the road. These trees are 10 feet behind a rubble retaining wall and 4 feet above the level of the road, which tends to make a dry site even drier. Between the wall and the traveled track is a line of sugar maple (*Acer saccharum* Marsh) two-thirds as tall as the larch, which has almost completely killed off the larch limbs on that side. As the larch stand only 20 feet apart in the row, full growing space is limited to one side. In some instances the growing space is further reduced by white pines (*Pinus strobus* L.) that have seeded in between the planted trees. The other trees are in groups, either all larch or mixed.

While no written records are available, reliable local information indicates that the larches were imported "from England" as small trees—probably 3 years old—in 1867. It is a matter of regret that nothing more definite can be ascertained about their origin. These larches have terminated their rapid height growth and show characteristic blunt tops. The trees vary somewhat in shape and in bark characteristics but careful comparison of the twigs, foliage, and cones shows that all the trees are *Larix decidua* L.[5] There is

[1]Ostenfeld, C. H. and C. S. Larsen. The species of the genus Larix and their geographical distribution. Copenhagen. 1930.

[2]Loc. cit.

[3]Hunt, S. S. European larch in the northeastern United States. Harvard Forest Bull. No. 16. Cambridge. 1932.

[4]Latimer, W. J. Soil survey of Rensselaer County, N. Y. U. S. Dept. Agric. Series 1932, No. 15. 1937.

[5]Schotte, G. Lärken och dess betydelse för Svensk skogshushållning. 1930.

some variation in height, which averages 65 feet at 74 years, with a maximum of 87 feet and a minimum of 47 feet. Diameter breast high is variable; average 17.7 inches, maximum 23.7 inches, minimum 11.4 inches. A good correlation is observable between d.b.h. and the size of the crown.

An ocular estimate showed that, of 55 living trees, 5 had a heavy, 14 a moderate and 16 a light crop of cones, while 20 had no cones at all. As the cones persist for some years, the estimate was of the cumulative crop, not that of the current year.

There is no record of the age at which the production of viable seed began but at 30 years reproduction appeared on suitable sites. Seedlings failed to establish themselves on mowed or cultivated land or in woods but did catch on pastureland and along hedgerows. For at least thirty years past these young trees have been dug and removed for ornamental planting. They can be found in dooryards in the neighboring sections of New York and Massachusetts. Countless others were destroyed by pasturing, brush-cutting, and fire. The remaining trees fall into well-defined age groups, probably correlated with intensity of farm practice. There remain today more than a thousand trees of all ages, scattered over half a square mile.

By far the greatest number of progeny have come up in an area of rough and now abandoned pasture lying east of the parent stand and further down the slope. The soil here is, in part, decidedly springy, with some free water and frequent peaty hummocks covered with Spirea, Andromeda, Vaccinium and Rubus. The remainder of the area is well drained and a typical site for white pine. The writer believes that there is no correlation between soil moisture and the establishment of seedlings, but rather a correlation with land use, the rough, wet and stony areas being untillable and so relegated to pasture. Other trees are found to the northeast and to the west. All lie within a mile of the seed source. Such distribution would be expected, as the seed is windborne and the prevailing wind is from the west, with occasional northeast storms in spring. Three distant trees, presumably from this source, are known. One is 1.5 miles to the southeast, one 2.6 miles to the southwest and one 3.3 miles to the northeast. The seed for the first may well have blown that far but there is no present explanation for the others.

The age of the progeny varies from 2-year seedlings—the smallest that can readily be found—up to 49 years, the age of one of the forest-grown trees. As some of the trees of the first American generation are producing seed, it is impossible to tell whether the smaller trees are of the first or the second American generation or crosses of the two. Seed has been collected from trees of the first American generation and 2-0 seedlings from them have been raised at the Saratoga nursery of the New York State Conservation Department. These were planted out in the spring of 1939.

The American generations occur as scattered single trees or small groups associated with such pioneer species as white pine, gray birch, red maple and aspen. Because of low stocking, the trees have deep, full crowns and but little clear length and their diameters are greater than would be expected for similar trees in a forest stand. Almost without exception, these trees are conical in form, with straight stems, pointed tips and an ascending branch habit.

The size of eight trees selected at random is shown in Table 2.

Table 2.—Dimensions of 8 Open-Grown Larches Selected at Random

Age	D.b.h. in inches	Height in feet
11	2.5	19
28	10.4	45
36	7.5	39
37	11.1	46
38	11.8	45
42	18.0	69
46	16.2	70
46	17.6	70

Three trees are known that have grown up in forest stands with hardwoods of equal age. Their dimensions (Table 3) give some idea of what may be expected under forest conditions.

Table 3.—Dimensions of 3 Forest-Grown Larches

Age	D.b.h. in inches	Height in feet
41	9.4	53
45	13.5	71
49	13.3	60

The 45-year-old trees listed in Table 3 is a fine specimen of forest-grown larch. Hunt[6] shows, for site I and age 45 a total height of 67.7 feet and a d.b.h. of 10.2 inches, which this tree exceeds by 5 percent and 32 percent respectively. The size

[6]Hunt, S. S. *loc. cit.*

of the other two trees listed in Table 3 indicates that they are growing under somewhat less favorable conditions.

As is characteristic of the genus, the height growth of young trees is rapid. Only white pine, among the conifers, compares with it. The height growth of 10 small open grown larches is shown in Table 4.

TABLE 4.—HEIGHT OF 10 SMALL OPEN-GROWN LARCHES

Total height in feet	Height increment in feet, 1938
2.14	1.02
3.19	1.05
3.52	1.57
4.45	1.76
4.90	2.11
5.54	1.73
6.91	2.76
7.44	3.80
7.99	2.79
9.95	2.67

The phenology of larch is often likened to that of some hardwoods. Measurements taken by the writer on a planted stand of European larch 2.25 miles to the northwest of this station and at 1,400 feet elevation indicate that, during the period 1933-1936, height growth began about June 1 and ended during the second week of September. Fragmentary data for hardwoods show a considerably shorter growing period.

European larch is generally considered to be sensitive to frost. Unquestionably, late spring frosts, such as those of June 7, 1932, and May 14-15, 1936, will kill trees less than 3 feet high but local experience shows that larches over 3 feet tall suffer less than do such associated species as red oak and white ash.

The larch sawfly (*Lygaeomatus erichsonii* Hartig) was present and deformed twigs can be found on both young and old trees. There is no evidence that their presence has seriously effected growth nor has any major defoliation been noted in the past ten years. The larch casebearer (*Coleophora laricella* Hbn.) is also present but not troublesome. Some of the younger trees, particularly those growing with white pine or scrub apple (*Malus* sp.) have been seriously trimmed by squirrels, a few being reduced to mere pikepoles. Such work is usually attributed to the chickaree (*Sciurus hudsonicus* Bangs) but the writer suspects, without being able to prove it, that the flying squirrels (*Glaucomys* sp.) may be at least partly responsible.

A few trees have lost their tops and some show mechanical injury but in no case has a serious invasion of wood-destroying fungi been noted. In 1935 an attempt was made to clear a corner of brushy pasture by mowing, followed by broadcast burning. Small seedlings were consumed but trees 2 inches d.b.h. and up showed no ill effects.

SUMMARY

A group of 74 year old European larch planted at Stephentown, N. Y., have produced an abundance of reproduction scattered over half a square mile. A few trees are formed up to a distance of 3.3 miles.

Maximum age of the reproduction is 46 years, with a height of 70 feet and a d.b.h. of 17.6 inches.

The progeny have been able to compete successfully with grass, shrubs, and native pioneer tree species.

The American generations have maintained good form and rapid growth. Some of them are producing cones and fertile seed.

BURNING PONDEROSA PINE SNAGS BY THE BASE-FIRE METHOD

By ERNEST L. KOLBE

Pacific Northwest Forest and Range Experiment Station

Most forest administrators want to get rid of snags in the easiest and cheapest way. For a considerable number of years forest experiment station workers in the West have attempted to determine the effectiveness of the base-fire method of burning snags. It had been observed that some trees may be kindled easily; others only with great difficulty. It now has been demonstrated that the time of the year and the amount of decay at the base of the tree are two very important factors influencing the success of the method for burning ponderosa pine snags. Snags with 50 percent or more decay are most easily destroyed by the base-fire method.

THE cutting or burning of standing dead trees to better the chances for controlling accidental fires has long been practiced in the ponderosa pine region. The common method employed is falling the snag with ax and saw. Disposal of snags by burning or by pushing them over with a tractor are other methods used east of the Cascade Range in Oregon and Washington but for the most part these methods are still on a trial basis.

Administrative tests of burning ponderosa pine snags by both the "bore-hole" and the "base-fire" methods have been made on many national forests and on some private holdings. As early as 1920 an extensive trial of snag burning was made in northeastern California in which some 4,600 dead pine trees were treated. The results of this early test[1] gave evidence, which repeated tests have confirmed, that disposal of snags by base fire burning may be done at low cost.

Burning snags by the base-fire method is possible in ponderosa pine chiefly because of rapid root decay which develops in this species soon after the tree dies. It is in the decayed wood of the butt and roots that the fire catches and spreads. Early root decay in pine, unlike Douglas fir, also causes natural fall of the snag in a relatively short time. The importance of this natural snag fall in rapidly reducing hazard was strikingly brought out by the results of an observational study[2] which showed a natural rate of snag fall for one locality of 15 percent in five years and over 80 percent in ten years. This natural process has the obvious advantage of no cost and, therefore, makes unnecessary artificial snag disposal except on extremely hazardous areas. If artificial disposal of snags is necessary, a method both cheap and effective in reducing the hazard is desired. Extensive tests have thoroughly demonstrated the cheapness of the base-fire method, but it must be applied during the safe season and not on areas with a heavy cover of inflammable slash. Why seldom more than half the snags fired by this method burn and under what conditions they may best be burned are questions for which answers were sought by the study described in the following pages. This investigation was designed to determine by field test the inflammability of pine snags in relation to degree of decay and other conditions; and to determine the season and weather conditions most favorable to burning by the base-fire method.

In this experiment snags were burned in the spring of 1935 and again in the fall of 1937. Both tests were made on the same 320-acre tract of virgin ponderosa pine forest within the Pringle Falls Experimental Forest in central Oregon. This area had on the average one pine snag to the acre. The same tract had previously been used by investigators of the Bureau of Entomology in a survey of trees killed by bark beetles, and in connection with that project the snags were marked each year since 1929 as to the year they died. These marked snags were treated in this burning experiment as well as those that had died prior to the marking in 1929. The field work was planned and supervised by the writer, but the actual burning was done in the spring test by L. W. Frost, and in the fall test by D. F. McKay, both having C.C.C. helpers. In these two operations Foreman Archie Brown of the Deschutes National Forest, an experienced snag burner, gave assistance and advice on burning technique.

The base-fire method consists in kindling a fire at the base of a snag near a cut chopped through the sapwood. In these tests the snags were fired in consecutive order as found on the plot without any selection as to size, amount of decay, or other conditions. As far as possible they were given the same treatment.

[1]Weaver, R. B. The burning of dead and down trees as a practical protective measure. Jour. Forestry. 19: 506-511. 1921.

[2]Keen, F. P. How soon do yellow pine snags fall? Jour. Forestry 27: 735-737. 1929.

Burning records were kept for 236 snags; of these 130 were burned in the spring and 106 were burned in the fall. In the spring 30 percent of the snags burned down while in the fall 62 percent of them burned down. Nearly 90 percent of the snags that took fire were consumed. This complete combustion of the most inflammable snags is an important feature in the reduction of the fire hazard by burning during the safe season and is an advantage not obtained when snags are pushed over or felled with a saw. The successful burning of a snag by the base-fire method depends to a large part on the condition of the snag and contributing factors of climate and site. Decay is the most important single factor in snag burning. All snags that were more than half decayed at the base were successfully burned, both in the fall and the spring tests. Snags with an estimated decay of from 20 to 50 percent burned down at the rate of 65 percent in the spring test and at the rate of 82 percent in the fall. The relative success in burning snags that varied greatly in amount of decay is surprisingly consistent considering that the estimates were based on external conditions and on comparatively few samples. It was found that on the evidences of external decay at the base of the snag an experienced worker can predict with a high degree of success the burning possibilities of standing dead trees. It was found that snags less than one-fourth decayed ordinarily will not burn by the base-fire method; those from one-fourth to one-half decayed have a good chance to burn; and those more than half decayed will almost always burn.

The average number of years required for a dead tree to become sufficiently decayed for burning is not known. The data in this test were too few to establish this fact. The records do show, however, marked difference in the rate of decay in snags of the same age class. The most recent snags fired were two years old and of the four tested none could be burned. The three-year-old snags, likewise, would not burn. Four of the dozen four-year snags sampled were successfully burned, and 10 of the five-year group of 14 snags were burned down. The great majority of the snags in this test were known to have been dead

Fig. 1.—This photograph was taken just 5 minutes after the match was struck to ignite this 38-inch pine snag. The snag fell eight hours later and was completely destroyed. The base fire banked with dry bark was built on the windward side.

Fig. 2.—The base fire burned out the roots in this snag and caused it to fall 28 hours after it was fired. The bole was too sound to burn and charred out.

for more than five years, some of them undoubtedly for many years. In this older group of 198 snags only about 60 percent were sufficiently decayed to be burned.

Other factors besides decay undoubtedly influence the burning down of snags. The small number of data in this test do not permit segregations to show such influences as radial thickness of sapwood, which varied from 1 to 7 inches in the snags fired, the diameter, and the tree class. The moisture content of the wood near the point where the fire was set was also measured and recorded. There is a great variation in the percent of water in the wood in April in relation to its dry weight, and a comparatively small range and lower percentages in December. The moisture percentages in the spring test ranged from 9 to 320 percent and in the fall trials from 5 to 45 percent. This would indicate that burning conditions are better in the fall for at that time more than three-fourths of the snags had sapwood with less than 20 percent moisture, whereas in the spring three-fourths of the samples had more than 20 percent moisture and some many times more.

During the fall burning test the weather was dry and very uniform with little wind. During the spring burning period, however, it was varied. The burning was most successful when winds were strongest and driest. The humidity also is a factor for on clear days 62½ percent of the snags fired were burned down; on cloudy days 53 percent burned down; and on rainy days 27 percent.

The cost of burning snags by the base-fire method was not checked in the present study. A few years previously these cost figures had been determined by officials of the Deschutes National Forest on an extensive scale for a similar virgin ponderosa pine stand. The first such test was made in the spring of 1932. At that time about 500 snags were fired for an average cost of 7.2 cents per burned snag. This included total cost of wages, travel, and the time spent in firing snags that failed to burn. In the second trial the following year over 2,500 snags were fired at 8.0 cents each for the snags burned down. Ordinarily from 80 to 115 snags are burned per man in a working day of eight hours. In the Pringle Falls tests the time spent igniting the snags was recorded. The average time was found to be about 6 minutes if pitchy wood was provided beforehand and 11½ minutes when this was obtained nearby. Skill in handling fuels, the number of snags per unit area, and the ease in getting over the tract are important factors in determining the time required for snag burning by the base-fire method.

Observation during the tests of numerous details in burning technique indicated that best results are obtained when the following points are observed in kindling the base fire:

(1) The opening cut into the sapwood should be made on the windward side far down on the base of the snag; if possible, near exposed roots or large sapwood checks.

(2) The cut should be about a foot high, a foot and a half wide, and a few inches deep.

(3) Pitchy pine shavings and kindling wood should be placed against the cut into the sapwood and ignited. Banking the fire with a few chunks of dry bark from the snag is an important final step. Building very large base fires increases costs with no apparent advantage.

The results of this study may be summarized as follows:

1. Pine snags are more successfully burned in the fall when the sapwood moisture content is low than in the spring.

2. An important advantage of the base-fire method is the complete destruction of a high percentage of the snags burned. In the Pringle Falls tests, nearly 90 percent of the snags that took fire were destroyed.

3. Decay at the base of a snag materially increases the chances for its disposal by the base-fire method. Snags with 50 percent or more decay are the best types for burning.

4. Not all snags may be burned by the base-fire method. Snags will seldom take fire that have less than one-fourth visible decay at the ground line. Old charred snags from which sapwood had previously been burned will not ignite from a base fire.

5. By observing the external evidence of decay, a worker may estimate, with a high degree of success, whether or not a certain snag will burn down by the base-fire method. Selecting snags for burning limits treatment to the most inflammable snags and to those which are likely to burn by this method, thus giving reduction in hazard at minimum cost.

6. Snags dead less than four years are seldom sufficiently decayed to ignite from a base fire.

7. Snags burn down in increasing numbers as wind velocity increases and humidity decreases.

BRIEFER ARTICLES AND NOTES

PRELIMINARY PROGRAM FOR ANNUAL MEETING

All Meetings at St. Francis Hotel
San Francisco, California

November 23-25, 1939

Thursday Morning, November 23

General Registration, 9 a. m.

Opening Session, 9:30 a. m.

Call to Order, C. F. Korstian, President.

General Theme: The Next Thirty Years.

Chairman, P. M. Barr.

A Program of Strict Federal Regulation.

A Program of Government Ownership of Forest Resources, by Lyle F. Watts, Regional Forester, Portland, Oreg.

A Program of Subsidized Forestry, by D. S. Jeffers, Dean, School of Forestry, University of Idaho, Moscow, Idaho.

Industrial Self-Regulation, by Clyde Martin, Forest Engineer, Western Pine Association, Portland, Oreg.

A Program of Education and Cooperation, by Stephen N. Wyckoff, Director, Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.

Discussion on all topics to follow the fifth paper.

Thursday Afternoon, November 23, 2 p. m.

Fire Problems of the Private Owner, by Bruce E. Hoffman, Charles Lathrop Pack Foundation, Portland, Oreg.

Planning for Tomorrow's Forest Crops, by William H. Price, Manager, Reforestation and Land Department, Weyerhaeuser Timber Company, Tacoma, Wash.

Problems of Fire Protection in California, by DeWitt Nelson, Forest Supervisor, Tahoe National Forest, Nevada City, Calif.

Forest Depletion: Federal Allowance for Selective Logging, a Definition and Explanation of Federal Requirements to obtain "Accelerated Depletion" for Selective Logging, by E. T. F. Wohlenberg, Principal Forester, Western Commercial Forests, State and Private Forestry, U. S. Forest Service, San Francisco, Calif.

Three other papers will be presented.

Friday Morning, November 24, 9 a. m.

Subject: Society Affairs.

Chairman, C. F. Korstian.

Report of Executive Secretary, Henry E. Clepper.

Report of Editor-in-Chief, Henry Schmitz.

Report of President, C. F. Korstian.

Reports of Committees.

Friday Afternoon, November 24, 2 p. m.

Young Foresters Session

Chairman, Robert A. Cockrell.

Range and Watershed Problems, by George W. Craddock, Jr., Intermountain Forest and Range Experiment Station, Ogden, Utah.

Private Forestry Problems, by Yale J. Weinstein, Forester, New Mexico Lumber and Timber Company, Bernalillo, N. Mex.

Forestry Education, by E. R. Martell, School of Forestry, University of Idaho, Moscow, Idaho.

Other speakers are also expected.

Friday Evening, November 24, 7 p. m.

SOCIETY OF AMERICAN FORESTERS DINNER

Toastmaster, EDWARD I. KOTOK.

This will be a stag banquet, at which there will be no speeches, the program consisting of skits presented by the members of the Society.

Saturday Morning, November 25, 9 a. m.

SUBJECT: FOREST RESEARCH AND THE NEXT THIRTY YEARS

Problems of Noncommercial Timberlands, by Charles A. Connaughton, Director, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Research in Forest Utilization, by Albert Herman, in charge of research, Western Pine Association, Portland, Oreg.

Problems of Reforestation, by Arthur G. Chapman, Silviculturist, Central States Forest Experiment Station, Columbus, Ohio.

Forest Economics Studies, by A. J. F. Brandstrom, Senior Forest Economist, Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.

HOTEL ACCOMMODATIONS

All sessions will be held at the St. Francis, the official headquarters hotel. All rooms have baths. Rates are quoted as follows:

Room with single bed: $4 up.
Room with double bed (2 persons): $6 up.
Room with twin beds (2 persons): $7 up.
Room with three single beds (3 persons): $9 up.

Reservations should be made direct with the hotel management. Members wishing to stay at the headquarters hotel are urged to make their reservations early because of the local collegiate football game scheduled at the same time as the meeting.

FIELD TRIPS

Several field trips are being arranged.

PROGRAM FOR THE LADIES

Owing to the unexpected early closing of the Golden Gate International Exposition, it has been necessary to change the projected plans for the entertainment of the ladies. There will be sightseeing tours arranged, however, as well as a luncheon or dinner, probably at Fishermen's Wharf in San Francisco.

Governor Olson of California will proclaim Thursday, November 23, Thanksgiving Day.

FOREST FIRE RESEARCH IN CANADA

Progress in forest fire research in western Canada is reported by the Dominion Forest Service, Department of Mines and Resources, Ottawa. During the past summer the system of forest fire hazard measurement developed at the Petawawa Forest Experiment Station in Ontario has been introduced in Riding Mountain National Park in Manitoba and in Prince Albert National Park in Saskatchewan. Four forest fire weather stations have been established in each park, and special studies are being carried on at Riding Mountain to adapt the system to the conditions in those two parks.

By means of specially prepared fire hazard tables and daily weather records, this system makes if possible to keep track of the variations in fire hazard from day to day and to adopt precautionary measures when the hazard is observed to be steadily rising to dangerous levels. This method

has now been in use for some years throughout the provinces of Quebec and New Brunswick where special studies have been made to adapt it to the particular forest and climatic conditions prevailing in those regions.

For the purpose of developing a system of fire hazard measurement suitable for use in Banff, Jasper, and Waterton Lakes National Parks on the east slope of the Rocky Mountains, a fully equipped forest fire hazard research station has been established at the Kananaskis Forest Experiment Station at Seebe, Alberta. The forest and climatic conditions in this area differ so markedly from those in eastern Canada that it has been found necessary to institute special studies properly to interpret the relationship between weather and fire hazard.

New Experimental Planting Project

What is believed to be the largest series of experimental planting experiments designed according to latest statistical methods has recently been undertaken around Norris Reservoir, near Norris, Tenn.

In carrying out the plan for unified development of the Tennessee Valley the Tennessee Valley Authority acquired considerable land as part of its reservoir construction program. Much of the more than one hundred thousand acres is recently abandoned farmlands, including many conditions of fertility and erosion. At the present time when both economic processes and governmental actions are taking land out of agricultural production the problem of forest and submarginal land management is very pressing. If left idle, such land is a menace to society since it may produce soil erosion to clog streams and reservoirs, rapid run-off to produce both floods and extremely low water stages, fires to spread to valuable adjoining lands, and diseases and insect pests to destroy both forest and agricultural crops. Moreover, tax returns from idle land are practically nil and no employment is furnished while even aesthetic and recreational values may be largely destroyed. Under proper management, based upon the results of scientific research, this type of land may not only overcome these negative values but may produce direct financial returns and indirect, but perhaps more valuable, returns such as increased employment, watershed protection, and wildlife and recreation.

A great portion of the Authority's land is submarginal for agriculture but excellent for timber growing. Even until recently, reforestation in the Tennessee Valley has been accomplished largely through the use of yellow pine and black locust for erosion control. It was believed that other species, on many sites, would produce greater financial returns, furnish more employment for local people, and perhaps afford greater watershed protection. However, little information was available on the growth and behavior of plantations of these species in this section. White pine (*Pinus strobus* L.), yellow poplar (*Liriodendron tulipifera* L.), black walnut (*Juglans nigra* L.), white ash (*Fraxinus americana* L.), northern red oak (*Quercus borealis* Michx.), white oak (*Q. alba* L.), black oak (*Q. velutina* LaMarck), southern red oak (*Q. rubra* L.), chestnut oak (*Q. montana* Willd), bur oak (*Q. macrocarpa* Michx.), red gum (*Liquidambar styraciflua* L.), and southern cypress (*Taxodium distichum* L.), were selected for these experiments with shortleaf pine (*Pinus echinata* Miller) and black locust (*Robinia pseudoacacia* L.), used for comparisons.

The Appalachian Forest Experiment Station, which is responsible for forest research in this region, undertook an extensive experimental planting project after offers of cooperation from the T.V.A. Since the lands to be planted are typical of large portions of the Great Appalachian Valley, results obtained from the experiment will be applicable over an extensive area extending from Tennessee northward into Kentucky and Virginia. Also it was found that the situation presented a most unusual and unprecedented opportunity for forest planting research through the cooperation of two government agencies. Findings to be secured will be valuable not only to the T.V.A., but also to other governmental agencies and private owners engaged in land management.

DESCRIPTION OF EXPERIMENTS

The project was initiated in the spring of 1937. Modern experimental design embodying the principles of replication and randomization and subject to statistical analysis was employed throughout. Of the eight experiments, four were designed to determine the relative suitability of thirteen species and ten mixtures for artificial regeneration on three aspects and three soil types. One experiment will investigate the effect of mixing black locust with four other species, two will test species for underplanting or interplanting

young natural stands—one understocked shortleaf pine, and the other thick sassafras stands.

Sassafras, pure and in mixture with persimmon, commonly occupies abandoned fields in the Great Appalachian Valley and may preclude establishment of desirable tree reproduction. In addition to the last experiment, an eighth experiment was designed to determine what type of cultural treatment, if any, is necessary to establish successful plantations on such areas. Three species—yellow poplar, white pine, and northern red oak—were planted and the sassafras is to be removed at various times and combinations of times.

A uniform spacing of six by six feet was used. After scalping, trees were planted by the center-hole method and a vegetative mulch applied. Mixtures were by nine-tree blocks, instead of by rows. In general, direct seeding of oaks and walnut was adopted with seedlings for other species. One-year stock was used with the exception of white pine which was 1-1.

ESTABLISHMENT

In the summer of 1937 the 117 blocks comprising 700 plots on 167 acres in seven areas were laid out and marked with posts. Soil pits were dug, samples collected, and profiles mapped. Vegetal cover was studied and mapped. Planting for the 1938 season began in February and was completed in March. Sixty blocks with 394 plots, covering 81 acres, were planted with approximately 98,000 trees and seed spots. In January and February 1939, approximately 106,000 trees and seed spots were used to fill the remaining 57 blocks with 306 plots on 86 acres. In addition some 47,000 trees and spots in both years were used for isolation strips and between blocks. In 1939, a small amount of replanting was necessary due to poor quality seed and rodent damage. Planting was done by C.C.C. labor.

Measurements of survival, height, and diameter are being made according to schedule and it is expected that valuable data will soon be available.

CLARENCE HILL BURRAGE,
Tennessee Valley Authority.

A Pocket Increment Core Slicer

In the JOURNAL OF FORESTRY for December 1938, John B. Cuno described a convenient and practical increment core slicer. A similar type of slicer, designed by R. P. Kiessel of the Western Electric Company in 1935, has been used with comparative success for the past three years by inspectors of the Western Electric Company in connection with the determination of depth of penetration and sapwood thickness in the creosoted southern pine poles purchased for Bell System use.

Considerable work has been done recently by the Bell Telephone Laboratories with a new slicer which is smaller and considerably more positive in its action. The new slicer (Fig. 1) has been used successfully on cores from creosoted and salt treated southern pine, creosoted lodgepole pine, and western red cedar. The current design fits in the hip pocket readily. The use of a Gem-type instead of a Gillette-type blade has minimized blade breakage. The head of the blade is recessed in the wood; and as a result one of the bolts in the upper member of the slicer is eliminated. The use of saw screws like those commonly found in saw handles, instead of bolts and butterfly nuts, makes a smoother piece of apparatus. The core holder (lower member) is made with a slot of only one-half inch depth. The two bolts shown in this member in the Cuno drawing have been eliminated because these bolts are not necessary for holding the core in place. In fact, some movement of the core is desirable as it permits the operator to rotate the core when lining it up so that the blade will cut with, instead of across, the grain.

The core holder illustrated is designed for use with cores of 0.2 inch diameter (K. & E. increment borers Nos. 4330 to 4335). An arrow is painted or marked on the upper member to facilitate rapid orientation and operation when a large number of cores are to be sliced and measured.

In practice the following technique has been found desirable: After the core has been lined up so that it will be sliced with the grain, a rapid but firm sliding of the upper member in

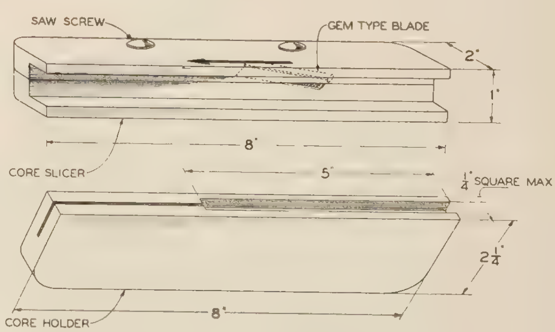

Fig. 1.—Details of a pocket increment core slicer.

the direction of the arrow over the lower member will usually result in a clean separation of the core into two halves. It is generally better to slide the upper member away from the operator while the lower member is held rigid.

It has been found by repeated experience that the inner rings of a tree of pole size, which have a relatively short radius, are frequently harder to slice than the outer rings. Resin deposits in the heartwood often make slicing more difficult. To avoid troubles of this kind, unless one wishes to study critically the very inner portion of a core from a pole, for example, the inner part can be measured and broken off before the sapwood and outer heartwood are split in the slicer.

G. Q. Lumsden,
Bell Telephone Laboratories, Inc.
W. P. Whyland, Jr.,
Western Electric Company, Inc.

A New Way to Use A Community Forest

A community forest can be used in many different ways. Standard uses are growing timber for profit, protecting watersheds, guarding expensive reservoirs from silting, providing recreation, furnishing shelter for fish and game, employing labor, furnishing municipal bridge timber and fuel for relief purposes.

One forester has found a community forest a formula by which to secure a good sized annual budget for his forestry and recreation operations. Reduced to its plainest form, the secret of this formula rests on the age-old fact that if you fulfill the wish of the people, they will follow you. The man behind the scenes knew what the people wanted. He proceeded to fulfill their wish and their response has exceeded his expectations.

The park system in Onondaga County, N. Y., has everything that an up-to-date park system should contain. Still the Onondaga County supervisors are willing to make an annual appropriations for the additional maintenance, improvement, and enlargement of a 2,200-acre community forest and ten parks. Why should they so freely lavish this money on a community forest when the park system should be adequate?

The writer made an investigation with Nelson C. Brown, the founder of the forest, and Marshall Higgins, the forester of the Onondaga County Community Forest.

They first visited an abandoned farmhouse which had been remodeled into a lodge. The land surrounding it had been reforested with over two million pine seedlings. They are making good growth, and, as they grow into money, portions of the forest are used for recreation. The lodge was complete with kitchen, living room, easy chairs, fireplace, and sun porches. Outside was a shuffleboard, horseshoe ground, giant checkerboard, swings, teter-totters, and a magnificent view of the countryside. This lodge, is reserved for the use of Sunday schools, women's clubs, church societies, and family reunions. That makes many organizations users and boosters for the forest. They pay $1 for the use of the entire lodge for one day—not $1 per person but $1 for the entire society. The place is booked up for most of the 1939 season.

A short distance from the lodge is a fenced-in enclosure containing pheasants. The local sportsmen's organization pays for feeding these birds and the necessary equipment to raise them. The county officials fence the ground on which to run them, and at the end of the year turn the birds over to the various sportsmen's clubs. The hunters get a better chance to do some hunting that way. And that makes every sportsman a booster for the forest.

On a hill are laid out a ski run, an ice skating rink, and a toboggan slide.

Another lodge building was built from logs cut on the forest. It is a nicely constructed building complete with everything that one needs for an extended stay. This particular lodge is rented out to civic clubs and organizations, such as the American Legion and the Knights of Columbus. That makes organizations of this type users and boosters of the forest. They pay $1 per club for the day. This house, too, is booked up for almost every week-end during 1939.

The land surrounding this clubhouse is more or less timbered and it, too, is under a practical plan of forest management which will provide for a sustained yield.

The community forest has also an up-to-date fish hatchery. The fishermen in the county pay for the rearing of the fish and at the beginning of each season each fishing club is given a supply for stream stocking. That makes all the fishermen users and boosters of the forest.

Throughout the forest there are camping spots with fireplaces, bridle paths, hiking paths, nature walks for nature studies and other forms of amusement. And that makes all the nature lovers users and boosters of the forest.

In other words, the Onondaga County Com-

munity Forest has been successful in furnishing outdoor activities to the citizenry in such a manner that almost everyone is able to use this forest. As a consequence over 500,000 people visited it during the season of 1938. And because of its popularity the economical minded county fathers are willing to authorize public money to maintain it. Almost everybody in Onondaga County is using the forest, all are getting some benefit from it, and all are boosting for it. The unemployed are finding work there too.

The forest now contains 2,200 acres of land, most of which has cost less than $5 an acre. Most of it was idle land; now it is growing into valuable trees. It has become a playground for clubs, parents, and children, and they demand its upkeep and enlargement. The forester in charge does not have to beg for appropriations, but is given freely all the money that he can advantageously use.

This example indicates how it is possible to capture, through the community forest, the love of an entire society.

If people are given a chance to use a community forest—if they are given a chance to use it in every conceivable way—a loyal group of customers is being developed who will boost for the forest and fight for its maintenance and extension. And while they use it for play and pleasure, it grows into value and money.

This same example could be repeated throughout the nation. There are many public spirited citizens who, if approached, will be glad to donate the land, free of charge, for a community forest as a memorial to themselves or beloved relatives.

Many counties in the United States can accumulate, through gifts and tax delinquencies, community forests of 2,000 to 4,000 acres. Those who are responsible for the establishment of a community forest will be remembered long after they are gone, for they will have left behind a living civic monument of enduring value and usefulness.

ERNEST O. BUHLER,
U. S. Forest Service.

AN EFFECTIVE "TREE DOZER"

Following up the assumption that greater accessibility is a requisite for better forest management, we recognize the value of the tractor equipped with hydraulic controlled adjustable blade for construction of truck trails. Our experience with such equipment suggested an addition to the blade for speeding up the construction and lowering the costs.

The usual procedure in timber road construction is to fell the trees on the right of way by axe and saw, which leaves the stumps to be removed by a combination of dynamite and tractor power. Anyone familiar with the equipment knows that smaller trees can be uprooted by the tractor, but what about the larger ones with deep or wide spreading roots? The answer is in using increased leverage, primarily in exerting pressure on the bole of the tree as high as possible. The secondary leverage naturally results from the weight of the top as the tree leans. Since the blade on the tractor when raised hits the tree with its lower edge—when on the level not more than possibly two feet above the ground—we need some device for hitting the tree higher up. Many types of device might be designed to serve the purpose, utilizing either the tractive power or the hydraulic, but for simplicity and minimum cost we have used a steel plate one inch in thickness welded to the blade of the bulldozer and projecting far enough forward so that it amply leads the lower edge of the blade when the blade is raised to maximum height.

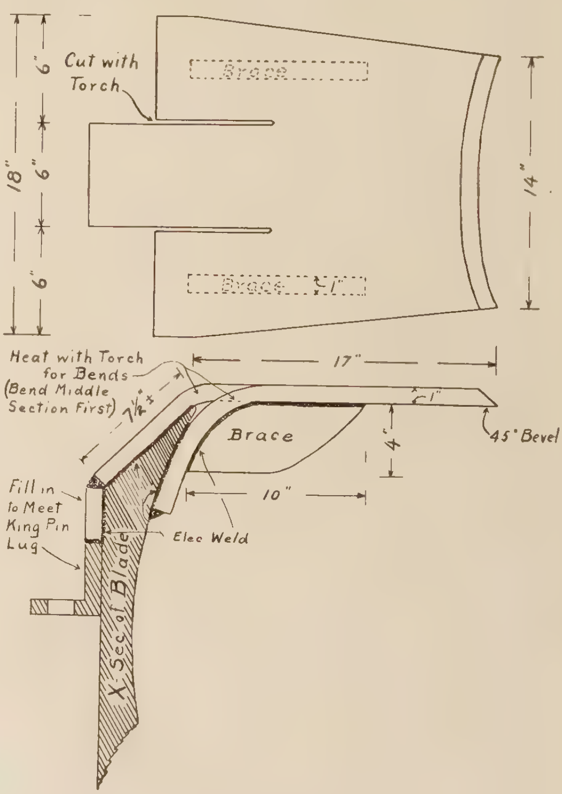

Fig. 1.—Sketch of tree dozer showing details of construction.

The sketch illustrates the general design and salient features of the "tree dozer" which we have used on the blade of a LaPlant-Choate Roadbuilder mounted on a Caterpillar RD 4. Figures 1 and 2 illustrate the equipment; Figures 3 and 4, the machine in action uprooting a tree; Figure 5, a stretch of road cleared and rough-graded through a 50-year old stand of northern hardwoods in northwestern Pennsylvania.

Without exhaustive studies comparative costs cannot be given; however, during 1938 with this equipment we built ten miles of road, serviceable for wood trucks, at \$88.72 per mile, which cost included everything excepting depreciation on equipment and general supervision. We believe that use of a "tree dozer" as compared to felling and stumping saves at least fifty percent in cost of clearing the right of way, and in addition gets rid of the surface root structure more effectively for grading.

Incidentally, we find it easier to construct road on an entirely new location rather than to follow old woods roads. With the equipment pictured we can handle trees 12 to 18 inches in diameter (occasionally larger), and in making new location it is possible to avoid the "tough ones." Figure 5 shows part of a 3/8 mile stretch of road which was cleared and rough-graded in one 8-hour day, using the equipment described, operator and one helper, actually six hours of tractor working hours. Of course, in this instance con-

Fig. 2.—Tree dozer blade welded to blade of the bulldozer.

Fig. 3.—Tree dozer in action exerting pressure high up on bole of tree.

Fig. 4.—Bulldozer blade pushing tree and roots to the side of the road right-of-way.

Fig. 5.—Road cleared and graded through a 50-year-old stand of northern hardwoods in northwestern Pennsylvania.

ditions were right and everything "clicked"; last year's average was 32 tractor working hours per mile.

In such equipment, adequate guard should be mounted over the driver's seat.

This description does not advocate use of a particular type of equipment; rather it attempts to show the possibilities of utilizing the principle of leverage in clearing whole trees from rights of way for roads or fire lanes.

E. O. EHRHART,
Armstrong Forest Company.

Notes on the 1937 and 1938 Acorn Crops in the Missouri Ozarks

Seedlings at the present time constitute less than ten percent of the reproduction in the oak-hickory stands on the recently established national forest purchase units in the Missouri Ozarks. The decline in seedling reproduction and the conversion to inferior coppice stands supposedly have been caused by the continued abuse, especially periodic burning, to which these stands have been subjected during the past century. However, there are apparently other delimiting factors because the transition back to natural seedling regeneration has not kept pace with the progress made in fire control and other phases of silviculture since the advent of national forests in Missouri. Studies of the 1937 and 1938 acorn crops on the Clark National Forest Purchase Units in the Missouri Ozarks, by the Central States Forest Experiment Station, contribute to a more general understanding of some of the reasons for this paucity of seedlings.

Approximately 98 percent of the acorns in the 1937 crop were defective soon after the majority of them had fallen. This estimate is based on an examination of 5,520 acorns collected from 600 one-milacre plots, located beneath the crowns of 150 white, post, black, scarlet and blackjack oak seed trees. About 67 percent of the acorns were infested with insects (weevil, moth, and gall), 16 percent were decayed, 13 percent were immature, and 2 percent were damaged by animals. There was on an average only one apparently sound acorn on each five milacre area under the crowns of the seed trees involved. Although small, this would constitute an adequate seed supply over a number of years if high germination and seedling establishment were realized.

The data on the 1938 acorn crop include the condition of the acorns, which was very similar to that of the 1937 crop, and information on their fate during the late fall and winter months. A total of 2,000 mature black oak acorns was dropped on burned and unburned plots in November, 1938 and examined at monthly intervals thereafter through April, 1939. The acorns were protected against animals by a complete cover of hardware cloth. There was a gradual decrease in the percentage of sound acorns, and by the latter part of March they were all defective. There was no apparent difference in the behavior of the acorns on the burned and unburned plots. None of these 2,000 acorns germinated during this period.

In November of the same year a total of 6,400 white and black oak acorns was placed on 64 plots located in five areas where hogs and squirrels were known to be present. Thirty-two of these plots were fenced and the remainder left unfenced against all livestock. When the acorns were collected and examined the following April it was found that, although over 90 percent of them were defective when placed on the plots, 30 percent had been removed and that 26 percent of those remaining on the plots had been injured by animals. There was no significant difference in the animal take or injury between species or between the fenced and unfenced plots. All the acorns remaining on the plots in April were defective. In addition to the decrease in the number of sound acorns, either through removal or through becoming defective, there was also a material decrease in the number infested with insects. Apparently these insect-infested acorns were taken in preference to those decayed or immature. As was true of the 2,000 acorns placed on the burned and unburned plots none of the 6,400 acorns remaining on these plots had germinated by April of the following year.

As was mentioned above, adequate fire control and a limited amount of timber stand improvement work have not resulted in a satisfactory increase in the amount of seedling oak reproduction in the Missouri Ozarks. If there is to be any immediate increase in the percentage of seedling reproduction it will be necessary not only to find means of increasing the yield of viable acorns, but also to find some means of protecting them against insects, rodents, and fungi, and otherwise to retain their viability until they have had an opportunity to germinate.

LORIN G. KAUTZ AND FRANKLIN G. LIMING,
Central States Forest Experiment Station.

REVIEWS

The Pressure Boys. By Kenneth G. Crawford. *308 pp. Julian Messner, New York. 1939. $3.*

Sub-titled *The Inside Story of Lobbying in America,* this book was written by a liberal newspaper man. Kenneth Crawford is Washington correspondent for the *New York Post,* and contributor to *The Nation.* He is a news reporter, not a columnist. Both write for newspapers but the difference between them is that whereas a columnist is free to express his opinions in his column, the news reporter writes factual information only and is denied self-expression.

"The result," admits Mr. Crawford, "is that I suffer from repressions, some of which I am working off in this book. If it is called biased and opinionated, as it doubtless will be, I make no apology. It is the unrepressed personal bias of a professionally impartial observer with no political affiliations and no doctrinaire axe to grind."

Among the several lobbies exposed are the sugar lobby, the motion picture producers' lobby, the utilities lobby, the big business lobby, the maritime shipping and railroad lobby, and the labor lobby. Sandwiched between these big-time pressure groups is another lobby whose existence was apparently unknown, even by those who are alleged to have participated in it, until it too was "exposed" by the author. This is the forestry lobby.

In the chapter "Roosevelt, the Dictator" the forestry lobby is credited—or shall we say, accused?—of scuttling the Reorganization Bill in 1938.

According to the author, the U. S. Forest Service controls the forestry lobby; it not only controls the American Forestry Association, the Society of American Foresters, and the lumber industry, but also influences the National Grange, the American Legion, the Chamber of Commerce, the National Lumber Manufacturers Association, women's clubs, the Catholic Church, and the Izaak Walton League. In short, the implication is that much of the opposition to the Reorganization Bill, killed in the House in 1938, was inspired by this forestry lobby. The implication is ridiculous.

Let it be understood that I do not for a moment question Mr. Crawford's sincerity of purpose, his personal honesty, and his integrity as a newspaper man. I do, however, question his knowledge of the conservation movement in the United States, and his right to tag with the opprobrious label "lobbyist" any person or organization not completely subservient to the ideology of the New Deal.

Long before the present administration's first Reorganization Bill was written, the Society of American Foresters and other conservation organizations now denounced as lobbyists opposed the transfer of the Forest Service from the U. S. Department of Agriculture. The reasons for this opposition are a matter of historical record, which the author apparently never examined, even supposing that he knew of its existence. For the record, it should be repeated that transfer of forestry from Agriculture was opposed because trees and the other products of the forest are growing crops like other agricultural crops, and as such are better studied, administered, and developed in the Department of Agriculture than in any other department. Thousands of words in dozens of articles written by scientists, foresters, and conservationists support this viewpoint. Most men and women who hold this opinion do so from honest conviction on scientific grounds. To imply, as the author does, that they are the dupes of the lumber industry and the stooges of a powerful lobby is a gratuitous insult to their intelligence and an imputation of lack of professional ethics which is as undeserved as it is unfair.

Convinced, as I am, of the author's sense of honor, I reject any notion of his intention to be unfair. The conclusion is therefore inescapable that in this instance Mr. Crawford is deceived by the propaganda of a lobby quite as powerful and effective as the one he sets out to expose. Any one mingling daily with newspaper men and read-

ing the flood of publicity handouts by federal departments would be naive indeed not to realize the extent to which all federal agencies propagandize in their own interests. To be able to perceive the Forest Service's alleged lobby against the Reorganization Bill, and to ignore the activities of those politicians with a stake in its passage, indicates a myopia which is hard to understand in one who claims to be "a professionally impartial observer."

This chapter on the so-called forestry lobby is not documented. The sources of the author's information—or rather, of his innuendoes—are not revealed; in fact, they are carefully hidden. One suspects that if they were revealed his claim to impartiality would fall apart.

For example, he mentions (page 196) a meeting of foresters and others interested in conservation in Ovid Butler's office in June 1937. Present were Ovid Butler and Harris Collingwood of the American Forestry Association, Fred Brenckman of the National Grange, Robin Hood of the National Cooperative Council, John B. Woods of the National Lumber Manufacturers Association, Chester Gray of the American Farm Bureau Federation, and myself. Each individual present had a legitimate interest in any legislation affecting forestry and agriculture. This group—according to the author, "this impressive group"—is described as "the nucleus of a powerful lobby already organized." Actually the conference, which met informally, which was not secret, and which most certainly had no sinister motives, was called to consider the matter of proposed federal reorganization which had been discussed in the press for several weeks. Crawford's implication is that those present were conspirators against the administration, meeting to sabotage its legislative program, and planning to wield enormous but unspecified power which he apparently believes they possessed. But it is hard to convince one's self that he is serious, that he did not write with tongue in cheek. It is a pity to destroy his dramatic illusion, but the whole idea is sheer nonsense.

Obviously, foresters are vitally interested in any movement, legislative or otherwise, that may affect their profession. They are most certainly interested in legislation before Congress. Foresters frequently testify at Congressional hearings on the merits of such legislation. Members of Congress have at times sought the advice of forestry organizations on technical matters. They have even been known to follow it! Is this lobbying? Again, I say nonsense.

Mr. Crawford finds a sinister purpose in a meeting of foresters in a forester's office. Since when has it been wrong for citizens peaceably to assemble? Three foresters, who called on a United States Senator to discuss a bill reported out by a committee of which he was a member, are denounced as lobbyists. Since when has it been improper for citizens to petition the government? If foresters, or any other group of citizens, see faults in proposed legislation, is there any reason why they should not say so? Until the Bill of Rights is abrogated, foresters will fearlessly resist regimentation, whether Cabinet members, repressed newspaper writers, and politicians like it or not.

American foresters have witnessed the sorry spectacle of a regimented forestry profession in certain totalitarian countries. In one such nation the professional forestry societies were wiped out by state decree and a state-controlled organization substituted for them. The success of these foresters' professional careers is made dependent, not on professional competence, but on adherence to party, on freedom from "racial impurity," and on obedience to the authority of a "chief forester" who is not a forester but a professional soldier and dictator. Foresters want none of this in America.

I hate to spoil Mr. Crawford's well-built edifice, but in trying to make of the Society of American Foresters a powerful lobby he has erected a house of cards. He imputes, unintentionally I believe, discreditable motives to a professional group which, though numerically small, is making substantial and lasting contributions to American social and economic progress. And lastly he impugns the honor of a federal bureau whose civil servants enjoy a reputation for honesty, fair dealing, and public service not exceeded by any other in the entire government.

This book was evidently written from a sense of white-hot indignation. The sentiment does the author credit, though he could have carried greater conviction in several chapters had he used restraint instead of sensationalism. He has thrown wide the doors of a lot of dark and smelly closets; in every one he has found a lobbyist. Doubtless most of those he found were lobbyists, but some were just as certainly honest citizens surprised while innocently seeking places to hang their hats.

I hope many foresters will read this book. First, because it treats of a subject about which

the members of a profession, who are largely publicly employed, should have information. Secondly, because it shows how an organization that attempts to safeguard professional interests may, when it stands in the way of powerful officialdom, be accused of the very practices it abhors and strictly avoids.

An index in the book would be helpful.

HENRY E. CLEPPER.

Elementary Forest Mensuration. By M. R. K. Jerram. (With a chapter on The Measurement of Forests by R. Bourne.) *x + 124 pp. Illus. Thomas Murby & Co., London, and Nordemann Publishing Co., New York. 1939. $2.45.*

This textbook was designed with the idea of providing a working knowledge of forest mensuration for the average run of practicing foresters. Those students who intend to become specialists or research workers will find it, therefore, too elementary and the treatment of the subject somewhat superficial. On the other hand, a vast majority of readers who have no intention of going deeply into the subject will like this primer and consider it a truly welcome addition to the literature of the field.

The chief merits of the book are its simplicity and compactness. The style of writing is clear and simple. It opens with a brief review of the main objects of forest mensuration. The subject matter itself is divided into eight chapters: The Theory of Tree Measurement, The Measurement of Felled Trees and Their Out-Turn, The Measurement of a Standing Tree, Volume Tables, The Increment of Individual Trees, The Measurement of Woods, Yield Tables, The Measurement of Forests. Much of the text is styled after Schlich's *Manual of Forestry*, Volume III, now out of print. The treatment of the subject is descriptive rather than analytical. The customary graphic methods are entirely omitted and the use of statistical methods is avoided throughout the text for fear that they would "impose an undesirable burden."

The book is intended primarily for British university and college students. Although it provides a good basis upon which a well-rounded course may be built, it is deficient at one point—it fails to give adequate recognition to the fact that training requirements in forest mensuration today are much broader than they were, say, twenty years ago. Even the men in the field will find that a number of important problems in the book are not sufficiently elaborated and that the author, in his intense desire to simplify the text, has oversimplified certain matters that require a definite analytical approach. For example, the necessary steps in the preparation of a yield table are not worked out in sufficient detail. Furthermore, the reader is not told what constitutes normality and what are the fundamental relationships that underly the growth and development of stands. The increment of individual trees is not related to that of stands. Several outmoded methods of calculating volumes of sample plots have received undue prominence simply because no frequency distributions of trees and their volumes by diameter classes have been presented and explained. The discussion on timber estimating is somewhat vague and unduly brief.

The scope of forest mensuration and its methods have not remained stationary. Much progress has been made of late through adaptation of graphic and statistical methods and techniques to the solution of many common problems in the woods. The rudiments of these methods are being gradually acquired even by the most practical men themselves. It is for this reason that the reviewer believes that a modest use of graphic methods and statistical conceptions would have aided the student greatly without reducing the audience to which the textbook has a definite appeal.

S. R. GEVORKIANTZ,
Lake States Forest Experiment Station.

Wood Pulp. By Julius Grant. *xi + 209 pp. Chronica Botanica Company, Leiden (Holland), and G. E. Stechert, New York. 1938. Seven guilders or about $4.*

This is one of a series of publications known as Plant Science Books. The subject of wood pulp and paper manufacture is covered in a generalized way. The historical background of the industry is ably presented and the modern concept of cellulose, its production, purification (bleaching), uses both for paper and other products, and economic position in world markets are discussed in an interesting and concise way.

In outline the treatment is conventional, dealing first with wood and its preparation, secondly

with the standard pulping processes, third with methods of purification, conversion, and testing, and last with a discussion of uses. One lack is any mention of the neutral chemical or semichemical pulping processes which have assumed considerable importance in the United States in recent years. Features of the book are its full discussion of the testing methods currently used for evaluating wood and pulp and their significance, and the author's clear presentation of the position of wood in relation to other fiber sources in meeting present and future cellulose needs.

As a textbook or for general reference, where full detail of process or operation are not of primary importance, this book is excellent. Foresters should find it most useful.

C. E. Curran,
U. S. Forest Products Laboratory.

The Mahogany Book. By George N. Lamb. *64 pp. Illus. Mahogany Association, 75 E. Wacker Drive, Chicago, Ill. 1939.*

Although prepared primarily for architects, designers, furniture and cabinet makers, and sellers and users of mahogany generally, this handbook should be of interest to many foresters and to all wood technologists. It tells in nontechnical style the story of one of the world's finest cabinet woods.

The earliest surviving example of the use of mahogany dates back to 1514 in St. Domingo. The wood reached Europe before 1600. The 18th and early 19th Centuries were the golden age of cabinet and furniture making, when mahogany began to displace oak and walnut. The great craftsmen and designers of this period, whose names are still used to designate the styles they developed, were Chippendale, the Adam brothers, Hepplewhite, Shearer, and Sheraton in England, and Duncan Phyfe and William Savery in America. The author describes in detail the various periods of furniture.

True mahogany grows only in Central and South America, in the West Indies, and in western Africa. It does not grow in pure stands. In fact, it is so scattered that two merchantable trees to the acre are considered a good stand. A jungle tree, it is difficult and expensive to log and to transport to mill or market.

The booklet is attractively illustrated with numerous photographs. Several pages are devoted to natural-color pictures of the various figures in which mahogany may be sawn and finished.

Henry E. Clepper.

Machinery for Wood Preservation. *31 pp. Illus. Allis-Chalmers Manufacturing Co. Bull. 1834. Milwaukee, Wisconsin. 1939.*

The title belies the contents in that only 10 pages are devoted to photographs and descriptions of equipment. The principles and history of wood preservation are clearly outlined. The section on character of wood is well illustrated with photomicrographs of cross, tangential, and radial sections of conifers and broadleaf trees.

The Burnett, Full Cell Creosote, Card, Rueping, and Lowry processes are described and illustrated with graphs for each process, showing time and pounds and inches of pressure and vacuum for treating ties.

The economics of treating railway crossties and bridge timbers is worked out convincingly on a dollars and cents basis. Diagrams of the yard layouts of three plants show how lots of various sizes and shapes may be utilized.

Throughout the bulletin, there is a pleasing absence of "pushing" Allis-Chalmers; the format is good; the photographs, drawings, graphs, and tables well chosen.

E. G. Roberts,
Mississippi State College.

Sagas of the Evergreens. By Frank H. Lamb. *xi+364 pp. Illus. W. W. Norton & Co., Inc. New York. 1938. $3.50.*

Mr. Lamb's account of some of the most interesting evergreens of the world has very obvious virtues. It is written with real love of the subject by a man who has personally seen much of which he writes. His detailed knowledge is apparent on many pages, and his style is rarely dull. The numerous photographs are superb, and most of the diagrams, including a generalized map showing the world distribution of evergreen tree species, are excellent. The majority of foresters will enjoy adding *Sagas of the Evergreens* to their libraries, and handing it to lay friends.

Unfortunately, however, the subject — "the

story and the economic, social, and cultural contribution of the evergreen trees and forests of the world"—is encyclopedic, and some aspects of it simply do not lend themselves to categorical treatment. Furthermore, anyone who undertakes to render the complexities of nature simple, and as plain as a pikestaff, is under a very heavy obligation to check and re-check on his simplifications. After reading Mr. Lamb's history of the evolution of the *Gymnospermae*, and his account of photosynthesis and other physiologic processes of trees, one is reminded of the commentator on Lord Macaulay: "I wish I were as cock-sure of any one thing as Macaulay is of everything!"

Also, in his endeavor to maintain the literary form of a "saga," in which his beloved trees tell their own stories, Mr. Lamb has been forced to employ teleological explanations of phenomena that create a sense of unreality. No less a personage than President Korstian has introduced me to "teleology," which my dictionary defines as "the doctrine of design which holds that the phenomena of organic life and development can be explained only by conscious or purposive causes and not by mechanical causes." Not many foresters or botanists, I think, will agree with Lamb that "when we know more of *tree instinct and tree will* (the reviewer's italics) we shall be better able to appreciate them as cognate, living, sentient beings and will be more successful in planning their future production." That point of view would seem to us a fatal handicap to scientific writing, even for popular consumption.

Having already paid tribute to Mr. Lamb's unquestioned knowledge of certain subjects, I feel free to point out some inaccuracies which weaken the total effect. His statement that "redwood is unique among all conifers in its prolific reproduction by stump and root suckers" ought to mention pitch and shortleaf pines, which also reproduce freely from sprouts. Except when a fire was precisely hot enough to consume the thick bark of a big tree and char just through the cambium, would there ever be "a thin charcoal layer on the ring of the year of the fire"? In these days of mycorrhiza research it is to be feared that "Abies of the Lasiocarpa clan" misled Mr. Lamb with this confidence: "I have millions of tiny little root hairs on all my live roots." The carpenters and builders of the East have led a dog's life for many decades if Lamb means literally his statements that "To the carpenter and builder 'hemlock' lumber is anathema. His eastern hemlock is not durable, it is hard-grained, difficult to work, splits at the least provocation and curls and twists provokingly." A careful check against Dr. Sargent's published data would have avoided such absurd dwarfing of the maximum heights of eastern pines as Lamb is guilty of. (Norway pine is "from sixty to ninety feet high"; loblolly is "sometimes more than a hundred feet high"; Lamb's "large primeval white pines" fall from 70 to 100 feet short of Sargent's maximum height for *Pinus strobus*).

Longleaf pine is certainly not noted for "its profuse reproduction under almost any condition," nor does it often produce "good lumber at forty to fifty years." Again, it is astonishing that any modern writer on the subject of naval stores should describe only the archaic "box" as the receptacle for resin of chipped (*not* tapped) trees. It is a great pity that errors such as these mar a volume that has much to commend it.

An extraordinary omission from even a "Selected Bibliography" on conifers of the world is the fine *Handbook of Coniferae* published in London in 1931 by Dallimore and Jackson.

R. D. Forbes,
Allegheny Forest Experiment Station.

German-English Science Dictionary for Students in the Agricultural, Biological and Physical Sciences. By Louis De Vries. *x+473 pp. McGraw-Hill Book Co., New York and London. 1939. $3.*

In this dictionary, which was compiled with the collaboration of the members of the graduate faculty of Iowa State College, the author has done an excellent piece of work. He presents in a compact volume which can easily be carried in a coat pocket some 48,000 terms, covering a wide range of biological and related sciences.

As he says, "The number of sciences that had to be studied made imperative a selection of the words to be included in a small and handy dictionary. Not all the names of animals, plants, sects, or chemical compounds have been included, since each subject would make a dictionary of its own." In view of these considerations, forestry is well represented, although the forestry vocabulary is far from complete. One looks vainly, for example, for such commonly encountered words as *Blendersaumschlag*, *Derbholz*, *Erntefestmeter*, *Hochdurchforstung*, or *Mittelwald*. *Femelschlagbetrieb* is defined as

"femel-cutting system," which is not very enlightening in the absence of a translation of *femel.* The translation of *Bodenreinertrag* as "net proceeds" is hardly adequate.

Although many tree names are included, many frequently occurring in the literature are missing, for example: *Arve, Douglasie, Flaumeiche, Moorbirke, Panzerkiefer, Ruchbirke, Sahlweide, Sandbirke, Speierling, Spirke, Stecheiche, Traubeneiche, Warzenbirke, Weissahorn, Weisskiefer. Holunder* is given as *Sambucus canadensis,* which would hardly be the species ordinarily referred to in German literature. *Kastanie* is given correctly as chestnut, but the fact that it frequently means horsechestnut is not mentioned.

All the important game animals of the German forest seems to be given, except *Elch* (the European moose). Numerous words common in works dealing with soils are also missing, for example: *Podsol, Glei, Keuper, Molasse, Molkenboden.* Among the forest fungi, the very common term *Hallimasch* is omitted, although its synonym *Honigpilz* is given.

Nevertheless, in spite of the lack of completeness, which the author himself recognizes, this dictionary should be exceedingly useful, not only to students but to anyone who has to read publications on German forestry and related subjects. The fact that it covers so many branches of science, many of which are closely related to forestry, makes it much more useful than a narrowly specialized forestry vocabulary or even one devoted to botanical terms in general.

W. N. Sparhawk.

Effects of Fire and Cattle Grazing on Longleaf Pine Lands as Studied at McNeill, Mississippi. By W. G. Wahlenberg, S. W. Greene, and H. R. Reed. *U. S. Dept. Agric. Tech. Bull. 683. 52 pp. Illus. U. S. Gov't Printing Office, Washington. 1939. 10 cents.*

This bulletin embodies the results of probably the first comprehensive experiment participated in by the Southern Forest Experiment Station. It was initiated in 1923, to explore the relations existing in the longleaf pine belt of the coastal plain among fire, cattle grazing, and pine reproduction. In common with the original four quarter-acre plots installed at Urania in 1915, the plan of the experiment called for annual burning which, although done at the proper season, February, was to be as intense or severe as possible. This burning, intended thus to show the maximum possible damage from annual winter fires, was to be contrasted with the effects of total exclusion of fire.

Apparently at that time no thought was entertained that fire might be used as a silvicultural agent, or that exclusion of fire might prevent reproduction of longleaf pine. In 1926 the reviewer published conclusions drawn from the experience of 13 years at Urania to the effect that neither annual burning nor complete exclusion would meet with continuing success in establishing longleaf reproduction, but that fires at two to three-year intervals would do so. The reviews published at that time were severe in condemning the use of fire in this type, and indicated clearly that such experiments as this bulletin describes were intended to demonstrate a preconceived position on fire, namely, its deleterious effects.

The first blow to this position came when S. W. Greene, co-author and cooperator for the Bureau of Animal Husbandry, announced at a Southern Forestry Congress in New Orleans that cattle grazed on the land burned annually had shown pronounced gains over those grazed on unburned lands, which is one of the findings now clearly established and proved in this final publication. The storm of protest and condemnation which arose from foresters in the attempt to discredit these facts and their author caused Mr. Greene in turn to become an open advocate of annual burning, and a critic, for the time being, of foresters and forestry in the South.

Now, in the results published, six years after the conclusion of this 10-year test which was finished in 1933, the deduction is drawn by the authors that "while annual burning improved the forage conditions for cattle, the results indicate that successful regeneration of longleaf pine, especially where the brown spot disease is epidemic, *may* depend upon some system of periodic controlled burning *rather than the extremes of annual fires or fire exclusion, both found unsatisfactory in this study.*" (Italics are reviewer's). Since this carefully conducted experiment had made no provision whatever for testing this method of using fire at two to three-year intervals, the opportunity was lost, as it was at Urania. However, in Figure 6, page 20, typical seedlings stunted by annual defoliation by fire, and by annual defoliation by brown

spot are shown contrasted to "a seedling from an adjacent area exposed to irregular periodic burning (not annual) during its early years, a type commonly regarded as 5 years old; it has a diameter of approximately 1 inch at the ground line and illustrates the general development necessary before the longleaf pine seedling can begin active height growth."

One conclusion seems to be drawn by the authors regarding the brown-spot disease *Lecanosticta acicola* (*Septoria acicola*) whose control or disinfection by fire constitutes one of the reasons for the beneficial effect of this agency in the period preceding height growth. This is that the excessive prevalence of the disease (after several years of fire protection) constitutes "local epidemic" conditions. For instance, on page 21, Siggers is cited as finding such a "local epidemic" at the Parker plots near Urania, while in the Chapman forest in the same "general vicinity" less severe infections were found in 1931, four years after fire. "This relatively light infection of a tract in the same general vicinity as the Parker plots illustrates the local occurrence of epidemics of brown spot disease." Actually, on the Parker plots and vicinity, brown spot disease was almost entirely absent for *at least five years* after "the fire" so that the comparison above when based on similar *histories* shows the same results. Also, since 1931, brown spot on the Chapman forest has become "locally epidemic" in the same manner, and for the same reasons as it did on the Parker plots, namely, continued absence of fire for a *longer* period than 4 years.

The phenomenon of abundant and healthy second growth after logging, which characterized the area chosen at McNeill, Miss., followed later by complete failure of the later crops of seedlings to attain height growth after 13 years in a stunted condition, is one of extreme importance, and is not adequately explained in this publication. This area was logged in 1902-1903. "Second growth stands—started active height growth about 1906." As a heavy seed year is known to have occurred in Alabama in 1908 there must have been a previous seed crop about 1901. The probability is that with the removal of the old timber in the following year or two, the released seedlings initiated height growth after the normal period of 5 years had elapsed and that *brown spot did not become epidemic until after the installation of fire protection in 1923.* Not one seedling of the crops of 1924 and 1927 or of later crops on the same site, whether burned annually or not at all, has ever been able to grow in height, though on last accounts (1937) many still survived after 12 years, in the enfeebled condition shown in Figure 6, page 20. Owing to the well known fact that the age of longleaf seedlings cannot be determined before height growth sets in, except by historical records, the authors mentioned the possibility that this reproduction which began its height growth in 1906 may have been suppressed for more than the normal 5-year period.

But there are two later cases which bear on this probability. First, the original reproduction at Urania of the crop of 1913, although protected absolutely from fire, remained free from brown spot until after height growth had started. Previous to this protection annual fires and thorough hog grazing had kept such seedlings completely out of the area, and in consequence, by inference, practically eliminated the brown spot disease. Again, on a longleaf area in the Angelina District of the Texas national forests, the brown spot disease, although now becoming prevalent as a result of sudden elimination of previous annual fires and hog grazing, evidently will not stop the seedling crop of 1935 from starting vigorous height growth, which in fact already began in 1939. The obvious conclusion is that thrifty second-growth stands will attain normal height growth in 5 years, in the absence of fire, when the *previous* practice of annual burning and hog grazing has reduced the chance of "local epidemics" of brown spot occurring for a period of 3 to 5 years following the seeding. On any area protected from fire for a few years, wherever located, brown spot will be *locally epidemic* as long as seedling crops of longleaf pine are present and in such cases will tend to stunt the crop permanently.

As annual defoliation is the factor that prevents normal development, the fact that survival was greatest (but without any height growth) on unburned and ungrazed areas merely indicates that such management of land obtains *neither the best forage* nor adequate tree growth, while grazing at least produces a mast crop. But again the error in this experiment consists of exposing the seedlings in their *first year* to both burning and grazing. Marvelous as is the resistance to fire, even of the 2 to 3-months-old longleaf seedling, most of the tender new seedlings are killed. Again, especially on carpet grass, the close cropping given this forage results in

practical elimination of the seedlings in the first summer, as shown by the data presented. After one summer's growth both of these dangers are practically over. Cattle avoid the seedlings, and winter fires, whether properly regulated or not, almost never kill them. The story of survival, under periodic burning, with protection from grazing for the first year, would have been very different, as shown by unpublished results at Urania.

It is shown that annual fires have reduced the growth of the 1906 crop of second growth by appreciable percentages. For height growth this was 23 percent (on 27-foot trees). Similar losses in d.b.h., basal area, and volume occurred. Again the fact must be considered that not only were the fires set annually but in each instance, as on the similar experiment on the Roberts plot at Urania, the effort was made to get as hot a burn as possible (as stated in the text) by firing at noon or afternoon instead of a controlled burn at night.

Loss of growth (as well as naval stores in Florida experiments) is apparently a direct corollary of defoliation. In March 1939, it was demonstrated at Urania that stands which had an accumulation of 23 years of rough could be burned against the wind at night with less than 5 percent of defoliation. Loss of increment under properly controlled 2 to 3-year burns, or, for second-growth pole stands, at 5 to 7-year intervals, has never been scientifically compared with that of severe annual burning.

The average gain of 37 percent in the weights of cattle pastured on annually burned areas over those on unburned pastures is explained by a careful and exhaustive analysis of the effect on distribution and abundance of forage species, and on the chemical composition of the soil. Physically, the burned and grazed areas show the usual hardening effects of these treatments, which on areas subject to erosion would be detrimental. Chemically, an increase in fertility is noted for the burned areas. Legumes noticeably increase through annual burning.

By way of introduction an interesting summary is given of the previous literature on the use of fire as a silvicultural agent, in which rather incomplete references are made to conditions and practices in India.

Under the conditions still existing in the South of rampant uncontrolled annual burning by stockmen on the one hand, and uncompromising resistance to any use of fire as a silvicultural agent, on the part of many state and national authorities, on the other, the authors are to be congratulated on having the results of this experiment published at all, much less with a lag of only six years between the completion of the text and its final appearance.

H. H. CHAPMAN.